

# Assignment 3

CS 595: Introduction to Web Science

Fall 2013

Shawn M. Jones

Finished on October 5, 2013

# 1

## Question

1. Download the 1000 URIs from assignment #2. "curl", "wget", or "lynx" are all good candidate programs to use. We want just the raw HTML, not the images, stylesheets, etc.

from the command line:

```
% curl http://www.cnn.com/ > www.cnn.com
```

```
% wget -O www.cnn.com http://www.cnn.com/
```

```
% lynx -source http://www.cnn.com/ > www.cnn.com
```

"www.cnn.com" is just an example output file name, keep in mind that the shell will not like some of the characters that can occur in URIs (e.g., "?", "&"). You might want to hash the URIs, like:

```
% echo -n "http://www.cs.odu.edu/show_features.shtml?72" | md5
41d5f125d13b4bb554e6e31b6b591eeb
```

("md5sum" on some machines; note the "-n" in echo -- this removes the trailing newline.)

Now use a tool to remove (most) of the HTML markup. "lynx" will do a fair job:

```
% lynx -dump -force_html www.cnn.com > www.cnn.com.processed
```

Use another (better) tool if you know of one. Keep both files for each URI (i.e., raw HTML and processed).

## Answer

Downloading the URIs was done relatively easily using the script shown in Listing 1.

The script is run like so:

```
./downloadURIs.sh urilist-final.txt shalist-final.txt collection
failedfile.txt
```

The arguments to the script are:

1. file containing URIs, one per line (`urilist-final.txt`)
2. file used to associate SHA-1 hashes with each URI, written to as each URI is processed, with the SHA-1 hashes being part of the filenames of the downloaded representations of each URI (`shalist-final.txt`)
3. directory name to store the downloaded representations (`collection`)
4. file used to store URIs that fail to download (`failedfile.txt`)

Once the script is run, the directory used in the third argument (`collection`) contains filenames, such as `f8017e9dd34d714681d55693689736d5d3f56021.raw` and `f8017e9dd34d714681d55693689736d5d3f56021.processed`. Files with a `.raw` extension contain the raw representation downloaded on line 32. Files containing a `.processed` contain the representation stripped of any HTML, done on line 42.

The file used in the second argument (`shalist-final.txt`) is used to associate these filenames to URIs (e.g. `f8017e9dd34d714681d55693689736d5d3f56021` corresponds to `http://www.cnn.com/2013/07/19/politics/obama-zimmerman/`).

The `set -e` on line 4 causes the script to exit at the first sign of trouble. This is a simple error-handling mechanism for Bourne shell scripts.

Unfortunately, the curl call on line 32 produced the following errors for several URIs:

- `curl: (7) couldn't connect to host`
- `curl: (18) transfer closed with outstanding read data remaining`
- `curl: (52) Empty reply from server`

This is why lines 35-38 exist. Line 31 undoes the error-handling mechanism so we can deal with the failed status on lines 33 and 35. Any URI that fails to download the first time is stored in a *failed file* (the fourth argument) which can then be fed through the script again, as the first argument, to (hopefully) successfully download the representations at a later time. Fortunately, only one re-run was required.

```

1  #!/bin/bash
2
3  # if anything fails , QUIT ASAP!
4  set -e
5
6  input=$1
7  listfile=$2
8  workingdir=$3
9  failedfile=$4
10
11 echo "Removing ${listfile}"
12 if [ -f "${listfile}" ]; then
13     rm "${listfile}"
14 fi
15
16 echo "Cleaning out ${workingdir}"
17 if [ -d "${workingdir}" ]; then
18     rm -rf "${workingdir}"
19 fi
20
21 mkdir -p "${workingdir}"
22
23 for line in `cat ${input}`; do
24     sha=`echo "${line}" | shasum | awk '{ print $1 }'`
25     echo "working on ${line}, now ${sha}"
26     echo "${line}      ${sha}" >> ${listfile}
27
28     outfileraw="${sha}.raw"
29
30     # curl appears to be where we can expect failure , so manage
it
31     set +e
32     curl -A "Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.1; WOW64; Trident/6.0)" "${line}" >> "${workingdir}/${outfileraw}"
33     status=$?
34
35     if [ $status -ne 0 ]; then
36         echo ${line} >> ${failedfile}
37         echo ${line} failed to work, moving on
38     fi
39     set -e
40
41     outfileproc="${sha}.processed"
42     lynx -dump -force_html "${workingdir}/${outfileraw}" >> "${workingdir}/${outfileproc}"
43     sleep 1
44 done

```

```
45  
46 echo "finished"
```

Listing 1: Bourne-Again Shell Program for downloading URIs from Assignment 2

## 2

### Question

2. Choose a query term (e.g., "shadow") that is not a stop words (see week 4 slides) and not HTML markup from step 1 (e.g., "http") that matches at least 10 documents (hint: use "grep" on the processed files). If the term is present in more than 10 documents, choose any 10 from your list. (If you do not end up with a list of 10 URIs, you've done something wrong).

As per the example in the week 4 slides, compute TFIDF values for the term in each of the 10 documents and create a table with the TF, IDF, and TFIDF values, as well as the corresponding URIs. The URIs will be ranked in decreasing order by TFIDF values. For example:

Table 1. 10 Hits for the term "shadow", ranked by TFIDF.

TFIDF	TF	IDF	URI
0.150	0.014	10.680	http://foo.com/
0.044	0.008	5.510	http://bar.com/

You can use Google or Bing for the DF estimation. To count the number of words in the processed document (i.e., the denominator for TF), you can use "wc":

```
% wc -w www.cnn.com.processed
2370 www.cnn.com.processed
```

It won't be completely accurate, but it will be probably be consistently inaccurate across all files. You can use more accurate methods if you'd like.

Don't forget the log base 2 for IDF, and mind your significant digits!

## Answer

Searching for the term *football* yielded quite a few results. This was done with the following command, which also selects out the top 10 for use in this exercise.

```
grep -i football *.processed | awk -F: '{ print $1 }' | sort |  
    uniq -c | sort -rn | head -n 10
```

Which returned:

```
19 87c993bbce1bd82db37cecc698c699e868d83fda.processed  
14 c60fdff864fe97d0a9072bae75dbac742b8e5ef4.processed  
10 9b4a0e8f58cac8c079780008762851aff600b8e7.processed  
8 5778ff1e943bcffb35088d5356e018fe91e6b348.processed  
7 9495c088454cb1f1e0dd8578a851daf9fda109a4.processed  
6 ebf64bd74b9b4d76e9eb1914943966291a3f6f80.processed  
6 e563ce7cf28c6844fd0bd962871530ec3d4ealc6.processed  
6 4dcb9dc20543b9b0936ad8a29ce9daccbc782b2.processed  
6 49c3c4171caf2902b5450b5c4e80c8dc4eb0073c.processed  
5 e2ab060d02ca13e0ddc8e5c30a732390045c039b.processed
```

This gives us raw term frequency for these files, but doesn't give us the word count so we can normalize it. To get the word count for the calculation, I did the following:

```
for i in `grep -i football *.processed | awk -F: '{ print $1 }'  
    | sort | uniq -c | sort -rn | head -n 10 | awk '{ print $2  
    }'`; do wc -w $i ; done
```

Which returned:

```
7339 87c993bbce1bd82db37cecc698c699e868d83fda.processed  
5634 c60fdff864fe97d0a9072bae75dbac742b8e5ef4.processed  
39130 9b4a0e8f58cac8c079780008762851aff600b8e7.processed  
3810 5778ff1e943bcffb35088d5356e018fe91e6b348.processed  
910 9495c088454cb1f1e0dd8578a851daf9fda109a4.processed  
3866 ebf64bd74b9b4d76e9eb1914943966291a3f6f80.processed  
2229 e563ce7cf28c6844fd0bd962871530ec3d4ealc6.processed  
3109 4dcb9dc20543b9b0936ad8a29ce9daccbc782b2.processed  
1922 49c3c4171caf2902b5450b5c4e80c8dc4eb0073c.processed  
3394 e2ab060d02ca13e0ddc8e5c30a732390045c039b.processed
```

Another step is necessary to get the URIs:

```
for i in `grep -i football *.processed | awk -F: '{ print $1 }'  
    | sort | uniq -c | sort -rn | head -n 10 | awk '{ print $2 }'  
    | sed 's/\.processed//g'`; do grep $i ../shalist-final.txt ;  
done
```

And normalized TF is calculated for each URI like so:

$$TF(football) = TF_{raw}(football)/occurrences(football)$$

Which returns the following:

```
http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?
utm_source=twitterfeed&utm_medium=twitter&utm_campaign=Feed%3
A+dailykos%2Findex+%28Daily+Kos%29      87
c993bbce1bd82db37cecc698c699e868d83fda
http://gif.mocksession.com/2013/02/rubio-is-thirsty/
c60fdff864fe97d0a9072bae75dbac742b8e5ef4
http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-
McCain-on-Cable-bill?utm_source=twitterfeed&utm_medium=
twitter&utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29
9b4a0e8f58cac8c079780008762851aff600b8e7
http://www.tampabay.com/news/politics/national/mitt-romney-is-
republican-partys-nominee-but-not-the-standard-bearer/1248507
5778ff1e943bcffb35088d5356e018fe91e6b348
http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/
index.html?hpt=hp_t3      9495
c088454cb1f1e0dd8578a851daf9fda109a4
http://host.madison.com/wsj/news/local/crime_and_courts/appeals-
court-reverses-federal-judge-s-decision-upholds-collective-
bargaining/article_c08d81f6_-61a3-11e2-8ab7-001a4bcf887a.html
ebf64bd74b9b4d76e9eb1914943966291a3f6f80
http://bleacherreport.com/articles/1699257-major-league-baseball-
-suspends-ryan-braun-for-remainder-of-2013-season
e563ce7cf28c6844fd0bd962871530ec3d4ea1c6
http://concord-nh.patch.com/groups/politics-and-elections/p/rep-
s-sieg-heil-causes-furor      4
dcb9dc20543b9b0936ad8a29ce9daccbc782b2
http://folksdresseduplikeeskimos.tumblr.com/      49
c3c4171caf2902b5450b5c4e80c8dc4eb0073c
http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-
Rick-Snyder-emergency-manager-law-repeal-Lansing
e2ab060d02ca13e0ddc8e5c30a732390045c039b
```

As the SHA-1 sums are the keys to join between these three outputs, the calculation of Term Frequency can be done easily by hand (because we only have 10 items), but where's the fun in that?



Because of the sort done on the items, they stay in order, meaning we don't need the keys to have Unix do the normalized TF calculations.

```
export i=0
for item in `grep -i football *.processed | awk -F: '{ print $1
}' | sort | uniq -c | sort -rn | head -n 10 | awk '{ print $1
}'`; do rawtf[$i]=$item; i=`expr $i + 1`; done

export i=0
for item in `grep -i football *.processed | awk -F: '{ print $1
}' | sort | uniq -c | sort -rn | head -n 10 | awk '{ print $2
}'`; do occur[$i]='wc -w $item | awk '{ print $1 }'`; i=`expr
$i + 1`; done

for i in `seq 0 9`; do echo "scale=5; ${rawtf[$i]} / ${occur[$i
]}" | bc -l; done
```

Which yields:

```
.00258
.00248
.00025
.00209
.00769
.00155
.00269
.00192
.00312
.00147
```

According to de Kunder, Google has currently indexed slightly more than 46,000,000,000 web pages[1].

Google gives 1,230,000,000 results for the word *football*.

This gives an inverse document frequency of (using significant digits rules for logarithms [2]):

$$\log_2 \left( \frac{46,000,000,000}{1,230,000,000} \right) = \log_2 \left( \frac{4600}{123} \right) = \log_2(37.4) = 5.225$$

The final piece of the puzzle is to calculate TFIDF, which is merely the multiplication of the normalized term frequencies for each page with the inverse document frequency calculated above.

Again, done with the help of our handy friends in Unix:

```
for i in `seq 0 9`; do echo "scale=5; ${rawtf[$i]} / ${occur[$i
]} * 5.225" | bc -l; done
```

Table 1 displays the results.

TFIDF	TF	IDF	URI
0.0402	0.00769	5.225	<a href="http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3">http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3</a>
0.0163	0.00312	5.225	<a href="http://folksdresseduplikeeskimos.tumblr.com/">http://folksdresseduplikeeskimos.tumblr.com/</a>
0.0141	0.00269	5.225	<a href="http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season">http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season</a>
0.0135	0.00258	5.225	<a href="http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29</a>
0.0130	0.00248	5.225	<a href="http://gif.mocksession.com/2013/02/rubio-is-thirsty/">http://gif.mocksession.com/2013/02/rubio-is-thirsty/</a>
0.0109	0.00209	5.225	<a href="http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507">http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507</a>
0.0100	0.00192	5.225	<a href="http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor">http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor</a>
0.0081	0.00155	5.225	<a href="http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html">http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html</a>
0.0077	0.00147	5.225	<a href="http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing">http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing</a>
0.0013	0.00025	5.225	<a href="http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29</a>

Table 1: Table of URIs, TF, IDF and TF\*IDF containing the word *football*, sorted by decreasing TF\*IDF

### 3

#### Question

3. Now rank the same 10 URIs from question #2, but this time by their PageRank. Use any of the free PR estimators on the web, such as:

[http://www.prchecker.info/check\\_page\\_rank.php](http://www.prchecker.info/check_page_rank.php)  
<http://www.seocentro.com/tools/search-engines/pagerank.html>  
<http://www.checkpagerank.net/>

If you use these tools, you'll have to do so by hand (they have anti-bot captchas), but there is only 10. Normalize the values they give you to be from 0 to 1.0. Use the same tool on all 10 (again, consistency is more important than accuracy).

Create a table similar to Table 1:

Table 2. 10 hits for the term "shadow", ranked by PageRank.

PageRank	URI
-----	
0.9	<a href="http://bar.com/">http://bar.com/</a>
0.5	<a href="http://foo.com/">http://foo.com/</a>

Briefly compare and contrast the rankings produced in questions 2 and 3.

## Answer

Using the URIs acquired from Question 2, I put each into one of the suggested Page Rank calculators. The results are shown in Table 2.

Unsurprisingly, SEO Central and PR Checker actually find the same value for the PageRank, whereas CheckPageRank provides a different answer altogether. This is because CheckPageRank doesn't actually give the PageRank for a given URI, it gives the PageRank for the base URI of a site.

For example, the URI `http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing` has a PageRank of 3/10 on the other services, but 7/10 with CheckPageRank. Even though this URI is used for input on that site, the output states **Google Pagerank for: freep.com 7/10**, which, when `http://freep.com` is put into one of the other services, gives a PageRank of 7/10.

So, this discounts CheckPageRank as a good source for calculating PageRank on a given URI.

Table 3 shows the PageRank values for the given URIs, normalized with *Not available* replaced with a value of 0.0. For comparison, Table 4 contains the PageRank and TF\*IDF values.

For this set of pages, there doesn't seem to be a whole lot of correlation between PageRank and TF\*IDF. The page with the highest TF\*IDF of 0.0402 has a PageRank of 0.0 and the page with the lowest TF\*IDF of 0.0130 has a PageRank of 0.1.

To contrast, Google's Number 1 link for the term *football* is `http://www.nfl.com/` which has a PageRank of 0.7.

Downloading the page and processing it, like in Question 1:

```
curl -A "Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.1; WOW64; Trident/6.0)" http://www.nfl.com > www.nfl.com.raw
lynx -dump -force_html www.nfl.com.raw > www.nfl.com.processed
```

and calculating TF\*IDF

```
echo "(grep football www.nfl.com.processed | wc -l / 'wc -w
www.nfl.com.processed | awk '{ print $1 }' ) * 5.225" | bc -l
```

gives a TF\*IDF of 0.0178, which is still lower than the highest TF\*IDF from Question 2.

This likely comes from the concepts that PageRank lets people "vote with their links" and that pages about a topic often do not heavily repeat that topic as a word in the page, meaning that PageRank is much more useful a ranking system for the World Wide Web.

Check PageR- ank	SEO Central	PR Checker	URI
8/10	undef	Not available	<a href="http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29</a>
4/10	0/10	0/10	<a href="http://gif.mocksession.com/2013/02/rubio-is-thirsty/">http://gif.mocksession.com/2013/02/rubio-is-thirsty/</a>
8/10	undef	Not available	<a href="http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3Adailykos%2Findex+%28Daily+Kos%29</a>
7/10	2/10	2/10	<a href="http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507">http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507</a>
9/10	undef	Not available	<a href="http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3">http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3</a>
6/10	undef	Not available	<a href="http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html">http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html</a>
7/10	undef	Not available	<a href="http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season">http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season</a>
5/10	undef	Not available	<a href="http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor">http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor</a>
3/10	3/10	3/10	<a href="http://folksdresseduplikeeskimos.tumblr.com/">http://folksdresseduplikeeskimos.tumblr.com/</a>
7/10	3/10	3/10	<a href="http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing">http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing</a>

Table 2: PageRank of URIs containing the word *football*, based on the Check-PageRank, SEO Central, and PR Checker Page Rank services

PageRank	URI
0.3	<a href="http://folksdresseduplikeeskimos.tumblr.com/">http://folksdresseduplikeeskimos.tumblr.com/</a>
0.3	<a href="http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing">http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing</a>
0.2	<a href="http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507">http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507</a>
0.1	<a href="http://gif.mocksession.com/2013/02/rubio-is-thirsty/">http://gif.mocksession.com/2013/02/rubio-is-thirsty/</a>
0.0	<a href="http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>
0.0	<a href="http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3">http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3</a>
0.0	<a href="http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html">http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html</a>
0.0	<a href="http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season">http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season</a>
0.0	<a href="http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor">http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor</a>
0.0	<a href="http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>

Table 3: PageRank of URIs containing the word *football*, based on the PR Checker Page Rank service, with *Not available* replaced with 0 and all other values normalized, sorted by decreasing PageRank

PageRank	TF*IDF	URI
0.3	0.0163	<a href="http://folksdresseduplikeeskimos.tumblr.com/">http://folksdresseduplikeeskimos.tumblr.com/</a>
0.3	0.0077	<a href="http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing">http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing</a>
0.2	0.0109	<a href="http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507">http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507</a>
0.1	0.0130	<a href="http://gif.mocksession.com/2013/02/rubio-is-thirsty/">http://gif.mocksession.com/2013/02/rubio-is-thirsty/</a>
0.0	0.0013	<a href="http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>
0.0	0.0402	<a href="http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3">http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3</a>
0.0	0.0081	<a href="http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html">http://host.madison.com/wsj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html</a>
0.0	0.0141	<a href="http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season">http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season</a>
0.0	0.0100	<a href="http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor">http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor</a>
0.0	0.0135	<a href="http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>

Table 4: PageRank of URIs containing the word *football*, sorted by decreasing PageRank, compared to TF\*IDF

## 4

### Question

=====  
=====Question 4 is for 3 points extra credit=====

4. Compute the Kendall Tau\_b score for both lists (use "b" because there will likely be tie values in the rankings). Report both the Tau value and the "p" value.

See:

<http://stackoverflow.com/questions/2557863/measures-of-association-in-r-kendalls-tau-b-and-tau-c>  
[http://en.wikipedia.org/wiki/Kendall\\_tau\\_rank\\_correlation\\_coefficient#Tau-b](http://en.wikipedia.org/wiki/Kendall_tau_rank_correlation_coefficient#Tau-b)  
[http://en.wikipedia.org/wiki/Correlation\\_and\\_dependence](http://en.wikipedia.org/wiki/Correlation_and_dependence)



## Answer

To calculate Kendall's  $\tau_B$ , one uses the following equation[6]:

$$\tau_B = \frac{n_c - n_d}{\sqrt{(n_0 - n_1)(n_0 - n_2)}}$$

where:

$$n_0 = n(n - 1)/2$$

$$n_1 = \sum_i t_i(t_i - 1)/2$$

$$n_2 = \sum_j u_j(u_j - 1)/2$$

$n_c$  = Number of concordant pairs

$n_d$  = Number of discordant pairs

$t_i$  = Number of tied values in the  $i^{th}$  group of ties for the first quantity

$u_j$  = Number of tied values in the  $j^{th}$  group of ties for the second quantity

The first step in calculating Kendall's Tau is to get the number of Concordant and Discordant pairs. I had a difficult time understanding how to go about this.

After some research, I came to understand that the variables used in Kendall's Tau are based on ranking, rather than the individual values themselves [3] [4] [5]. Table 5 shows the rankings listed with concordant and discordant pairs counted in columns **C** and **D** respectively, giving us  $n_c = 21$  and  $n_d = 24$ .

This gets us the top part of the equation, but not the bottom. For that we need the number of ties for each value.

For PageRank, from Table 3 there were only ties on values 0.3 and 0.0, so the ties are  $n_1 = \sum_i t_i(t_i - 1)/2 = t_{0.0}(t_{0.0} - 1)/2 + t_{0.3}(t_{0.3} - 1)/2 = 2(2 - 1)/2 + 6(6 - 1)/2 = 2(1)/2 + 6(5)/2 = 1 + 15 = 16$ . This sets  $n_1 = 16$ .

The TF\*IDF calculations had no ties, making  $n_2 = 0$ .

The total number of ranked items is 10, making  $n = 10$ , and  $n_0 = 10(10 - 1)/2 = 90/2 = 45$ .

Therefore:

$$\tau_B = \frac{21 - 24}{\sqrt{(45 - 15)(45 - 0)}} = \frac{-3}{\sqrt{30 \times 45}} = - \approx \frac{-3}{37} = -0.08$$

To get the  $p$ -value we need to calculate the  $Z$ -score, which, for Kendall Tau  $B$ , is:

$$z_B = \frac{n_c - n_d}{\sqrt{v}}$$

where

$$\begin{aligned} v &= \frac{(v_0 - v_t - v_u)}{18 + v_1 + v_2} \\ v_0 &= n(n-1)(2n+5) \\ v_t &= \sum_i t_i(t_i-1)(2t_i+5) \\ v_u &= \sum_j u_j(u_j-1)(2u_j+5) \\ v_1 &= \frac{\sum_i t_i(t_i-1) \sum_j u_j(u_j-1)}{(2n(n-1))} \\ v_2 &= \frac{\sum_i t_i(t_i-1)(t_i-2) \sum_j u_j(u_j-1)(u_j-2)}{9n(n-1)(n-2)} \end{aligned}$$

Wow!

Well, we shall start from the bottom.

As noted before, for PageRank, there 2 ties on 0.3 and 6 on 0.0, and 0 ties for any TF\*IDF values.

This makes  $v_2 = 0$  due to the fact that  $\sum_j u_j(u_j-1)(u_j-2) = 0$  because there are no ties in TF\*IDF values.

This makes  $v_1 = 0$  and  $v_u = 0$  for the same reason.

Seeing as we had ties in PageRank,  $v_t = 2(2-1)(2(2)+5) + 6(6-1)(2(6)+5) = 2(1)(4+5) + 6(5)(12+5) = 2(9) + 30(17) = 18 + 510 = 528$ , thus  $v_t = 528$ .

There were 10 items to compare, so  $v_0 = 10(10-1)(2(10)+5) = 10(9)(20+5) = (90)(25) = 2250$ , thus  $v_0 = 2250$ .

Now we have arrived at  $v = \frac{(2250-528-0)}{18+0+0} = \frac{1722}{18} \approx 96$ .

From before  $n_c = 21$  and  $n_d = 24$ , so the  $Z$ -score is

$$z_B = \frac{21-24}{\sqrt{96}} \approx \frac{-3}{9.8} = -0.3$$

Page Rank Ranking	TF* IDF Ranking	C	D	URI
1	2	8	1	<a href="http://folksdresseduplikeeskimos.tumblr.com/">http://folksdresseduplikeeskimos.tumblr.com/</a>
2	9	1	7	<a href="http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing">http://www.freep.com/article/20121205/NEWS15/121205082/Michigan-Rick-Snyder-emergency-manager-law-repeal-Lansing</a>
3	6	3	4	<a href="http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507">http://www.tampabay.com/news/politics/national/mitt-romney-is-republican-partys-nominee-but-not-the-standard-bearer/1248507</a>
4	5	3	3	<a href="http://gif.mocksession.com/2013/02/rubio-is-thirsty/">http://gif.mocksession.com/2013/02/rubio-is-thirsty/</a>
5	10	0	5	<a href="http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/05/09/1207970/-Agreeing-with-McCain-on-Cable-bill?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>
6	1	4	0	<a href="http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3">http://www.cnn.com/2013/04/23/justice/ohio-steubenville-coach/index.html?hpt=hp_t3</a>
7	8	0	3	<a href="http://host.madison.com/wsaj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html">http://host.madison.com/wsaj/news/local/crime_and_courts/appeals-court-reverses-federal-judge-s-decision-upholds-collective-bargaining/article_c08d81f6-61a3-11e2-8ab7-001a4bcf887a.html</a>
8	3	2	0	<a href="http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season">http://bleacherreport.com/articles/1699257-major-league-baseball-suspends-ryan-braun-for-remainder-of-2013-season</a>
9	7	0	1	<a href="http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor">http://concord-nh.patch.com/groups/politics-and-elections/p/rep-s-sieg-heil-causes-furor</a>
10	4			<a href="http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29">http://www.dailykos.com/story/2013/06/18/1216969/-D-C-Football?utm_source=twitterfeed&amp;utm_medium=twitter&amp;utm_campaign=Feed%3A+dailykos%2Findex+%28Daily+Kos%29</a>
<b>Totals</b>		21	24	

Table 5: Ranking of URIs by PageRank and TF\*IDF, with Concordant Pairs (C) and Discordant Pairs (D), for Kendall Tau calculations

## References

- [1] DE KUNDER, M. World wide web size: Daily estimated size of the world wide web. <http://www.worldwidewebsize.com>, Oct. 2013.
- [2] EULER, W. Significant figures when using logs. <http://bilbo.chm.uri.edu/CHM112/lectures/logsigfigs.htm>, Feb. 2005.
- [3] HOW2STATS. Kendall's tau - explained simply + examples (part 1). <http://www.youtube.com/watch?v=oXVxaSoY94k>, Sept. 2011.
- [4] HOW2STATS. Kendall's tau - explained simply + examples (part 2). <http://www.youtube.com/watch?v=V4MgE43SrgM>, Sept. 2011.
- [5] RESEARCH, S. Kendall's tau. <http://statistical-research.com/wp-content/uploads/2012/09/kendall-tau1.pdf>, Sept. 2012.
- [6] VARIOUS. Kendall tau rank correlation coefficient. [http://en.wikipedia.org/wiki/Kendall\\_tau\\_rank\\_correlation\\_coefficient#Tau-b](http://en.wikipedia.org/wiki/Kendall_tau_rank_correlation_coefficient#Tau-b), Aug. 2013.