CSCI 572 HW4: COMPARING SEARCH ENGINE RANKING ALGORITHMS USING SOLR

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News Website: FOX News

STEPS:
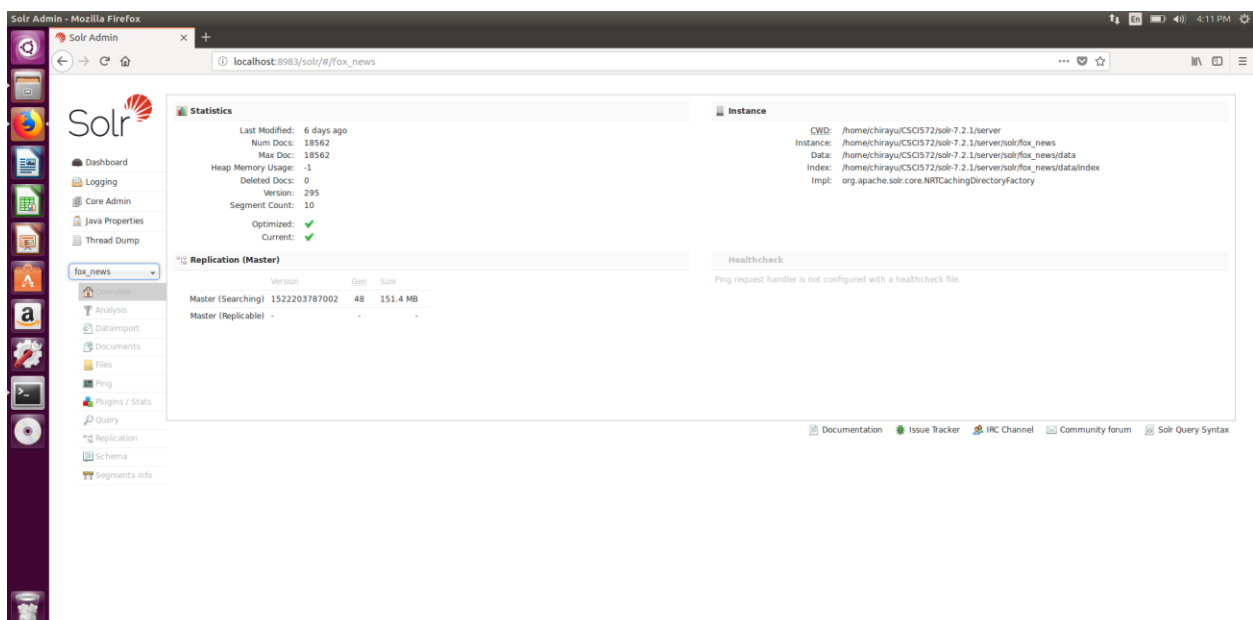
1. **Installing Ubuntu on Windows:**
   - I started with downloading 64-bit version of Ubuntu and VirtualBox. Following the steps given in the instructions manual, Ubuntu was installed successfully. Then, I installed Java 8 in Ubuntu.

2. **Solr Installation and Creating a Core:**
   - Next, I installed Solr using the given guidelines. After successful installation of Solr, started the server using the command: *$bin/solr start*
   - Solr was started on port 8983
   - Then, I created a core "fox_news" using the command *$bin/solr create –c fox_news* and made changes in file – 'managed-schema' as suggested in the guidelines.

3. **Indexing using Solr:**
   - To index html pages using solr, I unzipped the given .html files into HTML_FILES folder and indexed those files using the command: *$bin/post –c fox_news –filetypes html HTML_FILES/*
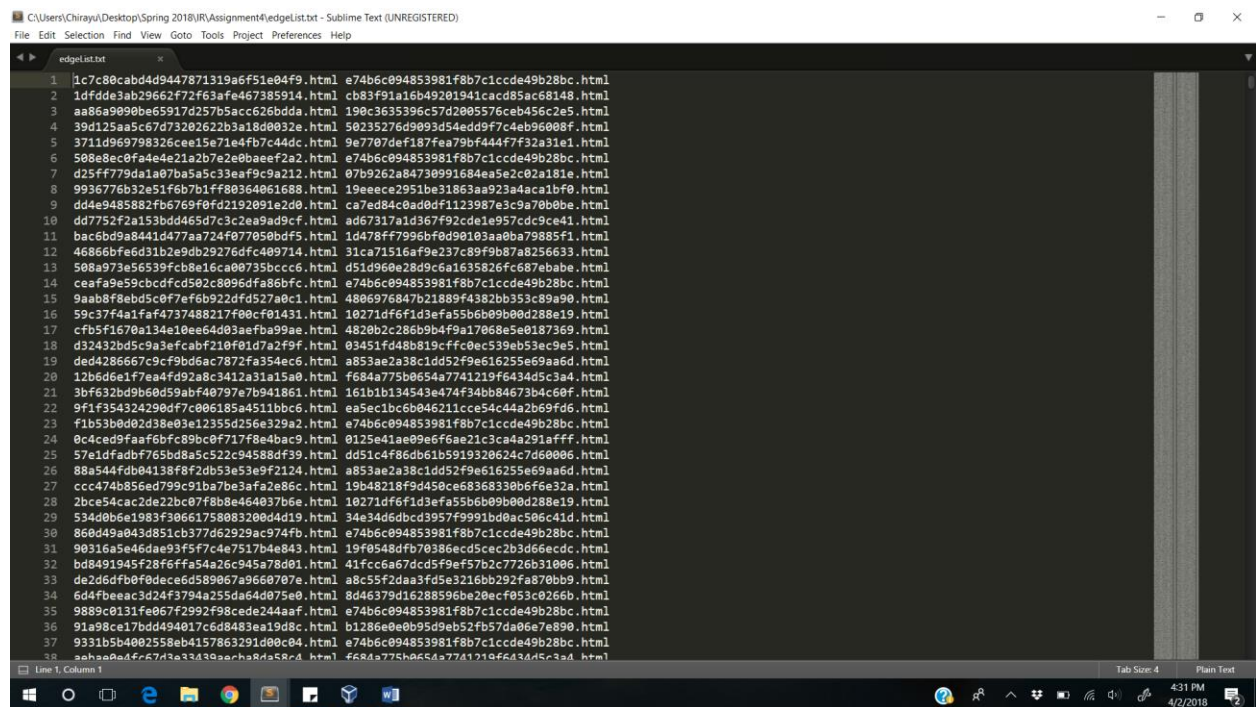   - The screenshot below confirms the indexing of files.

4. **Creating a PHP client that sends the request to Solr:**
   - Used the solr-php-client - https://github.com/PTCInc/solr-php-client . Cloned this repository using *$git clone* https://github.com/PTCInc/solr-php-client.git
   - Wrote program in PHP that allows the user to input query in a HTML form, and sends request to the Solr server. The results returned by the Solr server are formatted and parsed by the program.

5. **Extracting links from download HTML pages:**
   - To compute the page rank, I extracted the link structure from the downloaded web pages. I used *jsoup* library for this task which gave me an output file – *edgeList.txt.* Vertices in the graph are webpage files and detected edge between two files represent a link between two. Below is a screenshot of the edgeList file:

6. **Computing page rank using PageRank algorithm:**
   - I used an external file to manipulate the ranking of document in Solr. The *external_PageRank* file stores the PageRank scores. This external file basically contains a mapping from a key field to the field value. Example: *<docid> = <page_rank_score>*
   - For creating this external file, I made use of **NetworkX** library in Python, which helps in computing page rank of a graph, and the *edgeList.txt* file from the previous step. I used the following parameters to compute the page rank for the graph created using *edgeList.txt:*
   alpha=0.85, personalization=None, max_iter=30, tol=1e-06, nstart=None, weight='weight', dangling=None
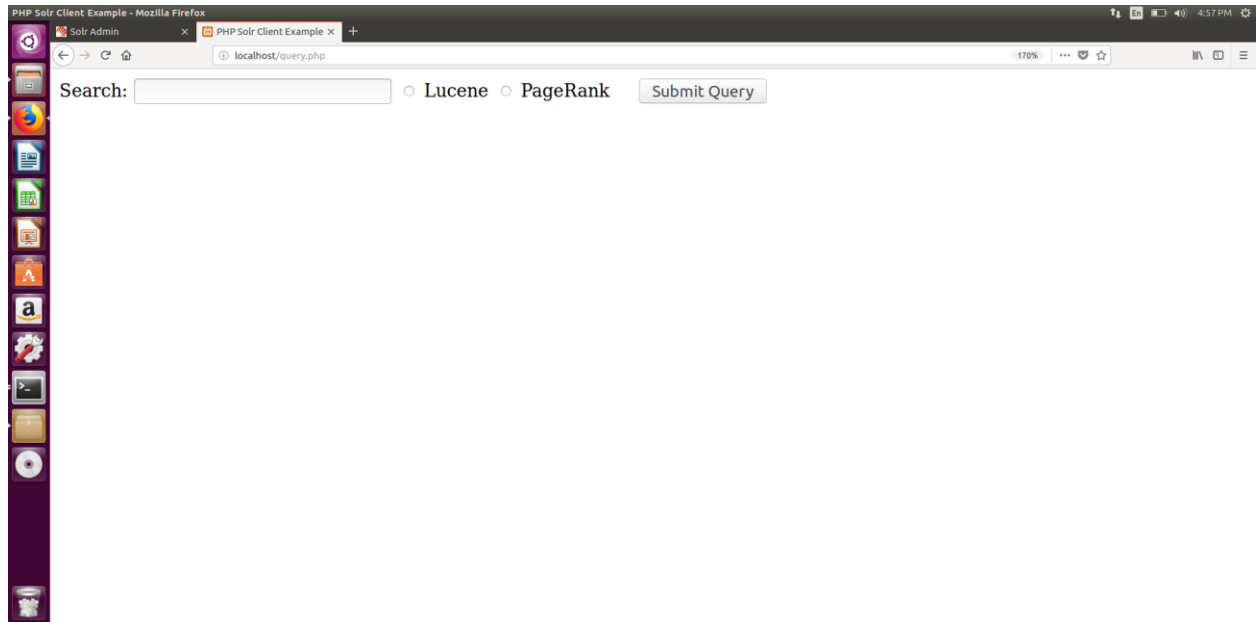
   - Below is a screenshot of the *external_PageRank.txt:*

-Then, I copied the *external_PageRank* file into the data folder of core 'fox_news' and made the suggested changes in solrconfig.xml.
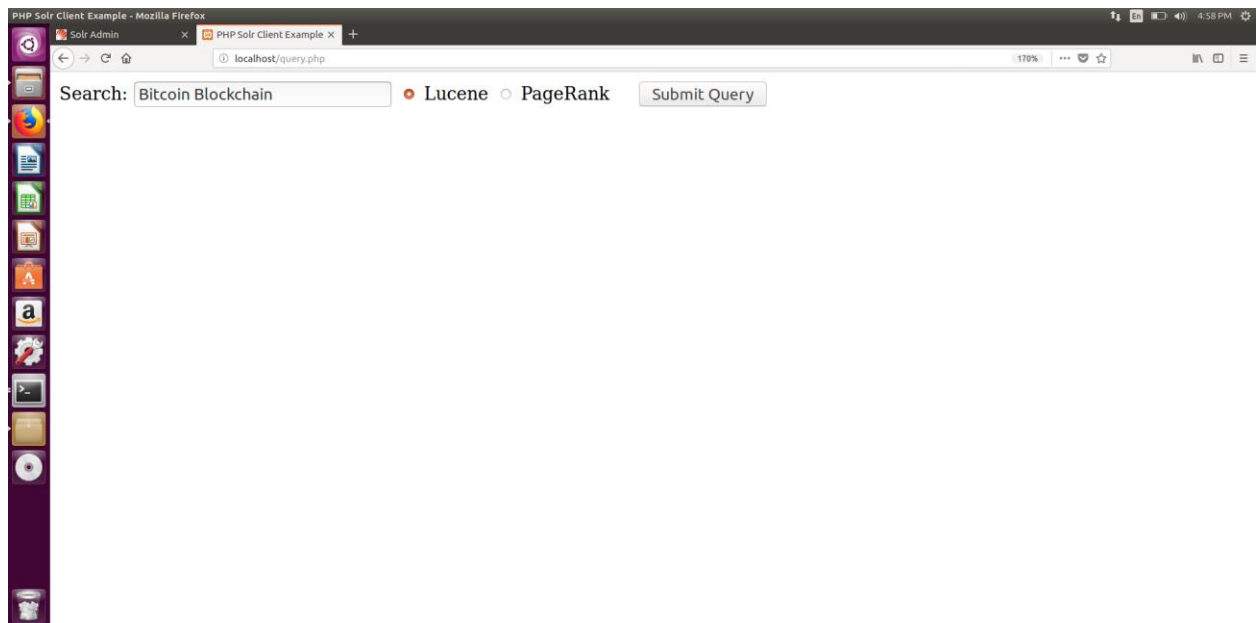
7. **Finally, I compared the results of Lucene and PageRank Algorithm.**

Documenting the flow for query '*Bitcoin Blockchain*' using screenshots:

1. **Search Page**

2. **Selecting Lucene for query '*Bitcoin Blockchain*'**

3. Top 10 search results of '*Bitcoin Blockchain*' using Lucene

Search: [Bitcoin Blockchain] ● Lucene ○ PageRank [Submit Query]
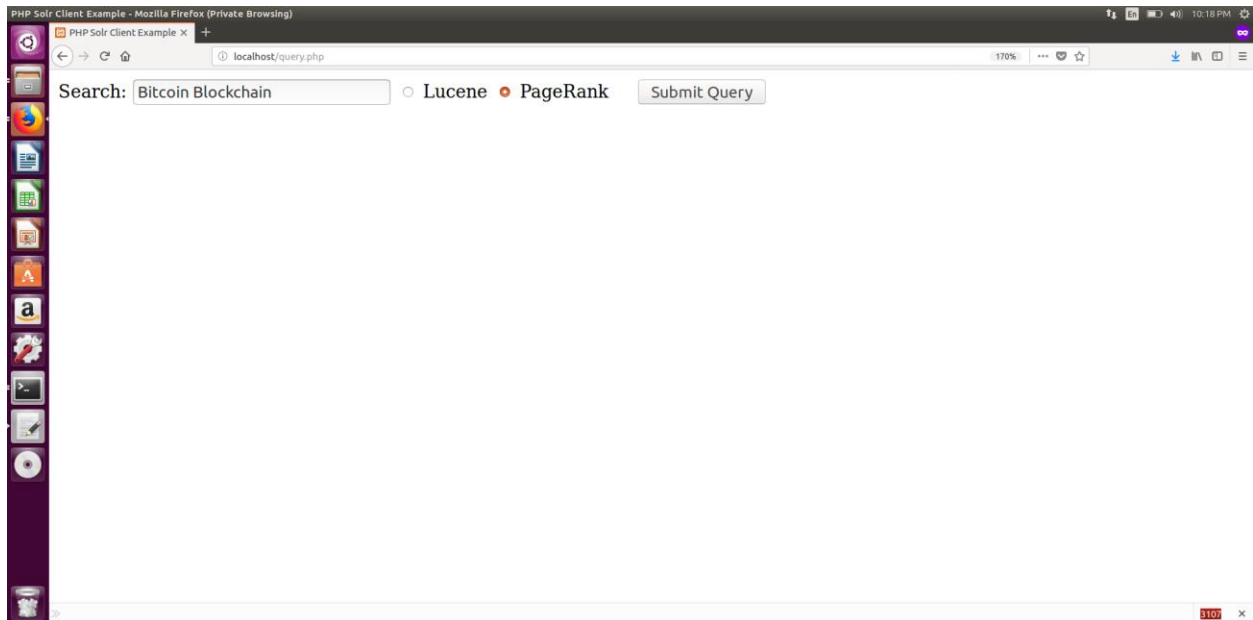
Results 1 - 10 of 128:

1. TITLE: Lawsuit alleges bitcoin pioneer became a thief | Fox News
   URL: http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html
   ID: /home/chirayu/CSCI572/HTML_files/69ad9b81695a19c8cfbb7062cde80aa9.html
   DESCRIPTION: Whether or not Craig Wright invented bitcoin, his early involvement in the cryptocurrency is clear.

2. TITLE: Lawsuit alleges bitcoin pioneer became a thief | Fox News
   URL: http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html
   ID: /home/chirayu/CSCI572/HTML_files/015ce645f77f26e2a99287ada6eea14c.html
   DESCRIPTION: Whether or not Craig Wright invented bitcoin, his early involvement in the cryptocurrency is clear.

3. TITLE: Lawsuit alleges bitcoin pioneer became a thief | Fox News
   URL: http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html
   ID: /home/chirayu/CSCI572/HTML_files/8ddb24956d5a34a7f8503f0ea5897426.html
   DESCRIPTION: Whether or not Craig Wright invented bitcoin, his early involvement in the cryptocurrency is clear.

4. TITLE: Arizona might allow people to pay taxes via bitcoin | Fox News
   URL: http://www.foxnews.com/politics/2018/02/07/arizona-might-allow-people-to-pay-taxes-via-bitcoin.html
   ID: /home/chirayu/CSCI572/HTML_files/7676e0854b64dd5c2570f949b4f5a54f.html
   DESCRIPTION: Digital currency can be used to pay for flights, furniture, music and even pizza. Now, pretty soon in Arizona, you may be able to use bitcoin to pay your taxes.

5. TITLE: Hackers steal as much as 10 percent of new cryptocurrency funds | Fox News
   URL: http://www.foxnews.com/tech/2018/01/24/hackers-steal-as-much-as-10-percent-new-cryptocurrency-funds.html
   ID: /home/chirayu/CSCI572/HTML_files/cd0382bf5179f59bfb337a2d52aa233e.html
   DESCRIPTION: Whenever a new cryptocurrency is launched, it usually goes through an initial coin offer where investors are brought in to get it off the ground. As much as 10 percent of those funds though, are being stolen by hackers.

6. TITLE: Lawsuit alleges bitcoin pioneer became a thief | Fox News
   URL: http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html
   ID: /home/chirayu/CSCI572/HTML_files/169ea197c44f5e00d89189b18ba72f14.html
   DESCRIPTION: Whether or not Craig Wright invented bitcoin, his early involvement in the cryptocurrency is clear.

7. TITLE: Lawsuit alleges bitcoin pioneer became a thief | Fox News
   URL: http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html
   ID: /home/chirayu/CSCI572/HTML_files/e0520682f158a81280f270e67031384d.html
   DESCRIPTION: Whether or not Craig Wright invented bitcoin, his early involvement in the cryptocurrency is clear.

8. TITLE: Hackers steal as much as 10 percent of new cryptocurrency funds | Fox News
   URL: http://www.foxnews.com/tech/2018/01/24/hackers-steal-as-much-as-10-percent-new-cryptocurrency-funds.html
   ID: /home/chirayu/CSCI572/HTML_files/ae301639fb671cf1787556a8d31b4042.html
   DESCRIPTION: Whenever a new cryptocurrency is launched, it usually goes through an initial coin offer where investors are brought in to get it off the ground. As much as 10 percent of those funds though, are being stolen by hackers.

9. TITLE: Smartwatches, better TV reception, Bitcoin investments and more: Tech Q&A | Fox News
   URL: http://www.foxnews.com/tech/2018/03/03/smartwatches-better-tv-reception-bitcoin-investments-and-more-tech-q.html
   ID: /home/chirayu/CSCI572/HTML_files/d87e8c6a44bba53433a2fbd4461553a5.html
   DESCRIPTION: Bitcoins! I want to know all about them and how I can make a million dollars!

10. TITLE: Smartwatches, better TV reception, Bitcoin investments and more: Tech Q&A | Fox News
    URL: http://www.foxnews.com/tech/2018/03/03/smartwatches-better-tv-reception-bitcoin-investments-and-more-tech-q.html
    ID: /home/chirayu/CSCI572/HTML_files/982d1ad9c7b7ce297b557091f1c466b7.html
    DESCRIPTION: Bitcoins! I want to know all about them and how I can make a million dollars!

4. Screenshot of first search result when queried 'Bitcoin Blockchain' using Lucene
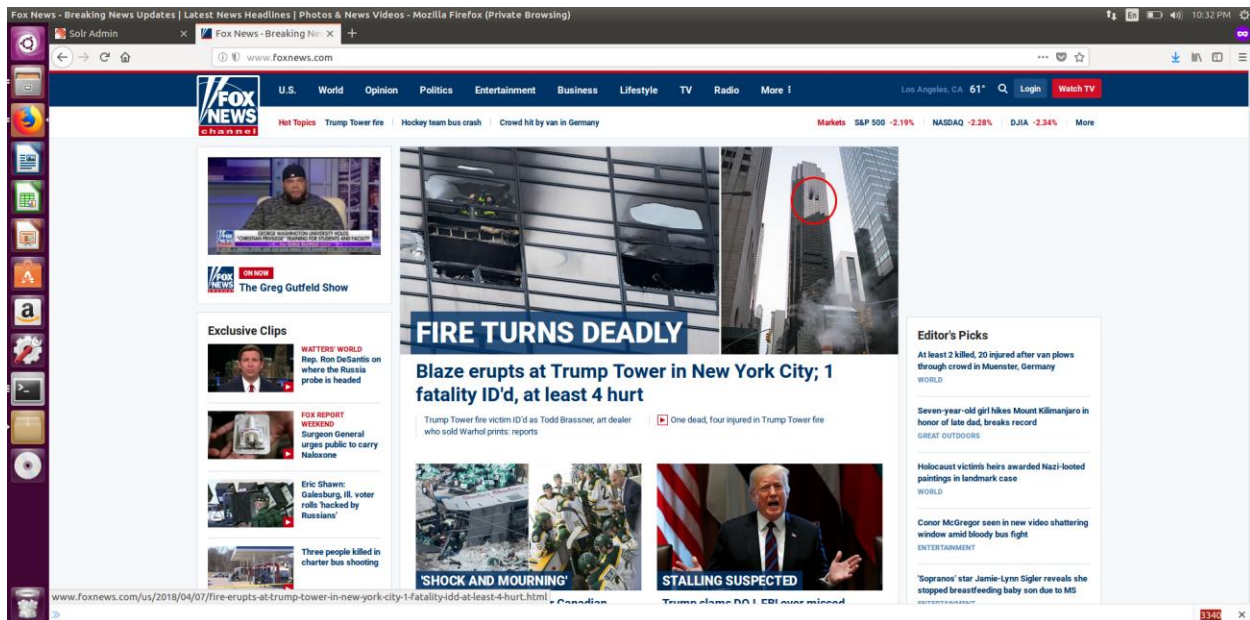

5. Selecting Page Rank for query '*Bitcoin Blockchain*'

6. Top 10 search results of '*Bitcoin Blockchain*' using PageRank

Search: [Bitcoin Blockchain] ○ Lucene ● PageRank [Submit Query]

Results 1 - 10 of 128:

1. TITLE: Fox News - Breaking News Updates | Latest News Headlines | Photos & News Videos
   URL: http://www.foxnews.com
   ID: /home/chirayu/CSCI572/HTML_files/e74b6c094853981f8b7c1ccde49b28bc.html
   DESCRIPTION: Most Watched. Most Trusted.

2. TITLE: Canadian CEO arrested in US on charges of supplying encrypted phones to Mexican cartels | Fox News
   URL: http://www.foxnews.com/tech/2018/03/15/canadian-ceo-arrested-in-us-on-charges-supplying-encrypted-phones-to-mexican-cartels.html
   ID: /home/chirayu/CSCI572/HTML_files/31a78f536e183e40f14c77666df97a2d.html
   DESCRIPTION: U.S. authorities last week arrested the head of a Canadian company that allegedly sold encrypted cellphones to Mexican drug cartels – shedding light on the growing use of private communications networks among organized crime groups looking to avoid the prying ears of the law.

3. TITLE: Computers | Fox News
   URL: http://www.foxnews.com/category/tech/topics/computers.html
   ID: /home/chirayu/CSCI572/HTML_files/a7607ff74bf445b02d87fe60ead0c814.html
   DESCRIPTION: N/A

4. TITLE: Biggest DDoS attack on record hits Github | Fox News
   URL: http://www.foxnews.com/tech/2018/03/02/biggest-ddos-attack-on-record-hits-github.html
   ID: /home/chirayu/CSCI572/HTML_files/796fda4f92f2193fb5753fd1f2ba5c7b.html
   DESCRIPTION: A new way to amplify distributed denial-of-service attacks ended up harassing Github on Wednesday.

5. TITLE: Hospital pays nearly $17G in bitcoins to hackers who disabled computer network | Fox News
   URL: http://www.foxnews.com/tech/2016/02/18/los-angeles-hospital-paid-17g-ransom-to-hackers-who-disabled-computer-network.html
   ID: /home/chirayu/CSCI572/HTML_files/26cab6844b0b988df08b6205059ea2a4.html
   DESCRIPTION: A Los Angeles hospital paid a ransom of nearly $17,000 in bitcoins to hackers who infiltrated and disabled its computer network because paying was in the best interest of the hospital and most efficient way to solve the problem, the medical center's chief executive said Wednesday.

6. TITLE: Ransomware: What is it? | Fox News
   URL: http://www.foxnews.com/tech/2017/05/15/ransomware-what-is-it.html
   ID: /home/chirayu/CSCI572/HTML_files/9645cf0dc017b497d9ffe9c623e4ceb9.html
   DESCRIPTION: The global "ransomware" cyberattack, known as "WannaCry," paralyzed computers that run Britain's hospital network, Germany's national railway and other companies and government agencies worldwide in what may be the largest online extortion scheme ever.

7. TITLE: Nintendo Switch becomes enormous hit, sells 10M units in under 9 months | Fox News
   URL: http://www.foxnews.com/tech/2017/12/12/nintendo-switch-becomes-enormous-hit-sells-10m-units-in-under-9-months.html
   ID: /home/chirayu/CSCI572/HTML_files/94c661ad304b5a9a2772c3c4e8cecad4.html
   DESCRIPTION: Nintendo announced its hybrid console, the Switch, has already sold 10 million units around the globe.

8. TITLE: Finding phone numbers, online incomes and more: Tech Q&A | Fox News
   URL: http://www.foxnews.com/tech/2018/03/09/finding-phone-numbers-online-incomes-and-more-tech-q.html
   ID: /home/chirayu/CSCI572/HTML_files/9ffdc464a8190e647edf9f1a09b207b0.html
   DESCRIPTION: Can I take my cable bill and phone off my taxes? I use it sometimes for work.

9. TITLE: Tech Q&A: Dueling assistants, outsmarting hackers, blocking texts, and more | Fox News
   URL: http://www.foxnews.com/tech/2018/02/04/tech-q-dueling-assistants-outsmarting-hackers-blocking-texts-and-more.html
   ID: /home/chirayu/CSCI572/HTML_files/abe9276a2e2f947d021207fdb09b9bd8.html
   DESCRIPTION: Want to know how to choose the best virtual assistant, outsmart hackers, and block texts? Then read this column.

10. TITLE: What is WannaCry ransomware? | Fox News
    URL: http://www.foxnews.com/tech/2017/05/15/what-is-wannacry-ransomware.html
    ID: /home/chirayu/CSCI572/HTML_files/adf6e188b7fd420ebed7aba66eb9228f.html
    DESCRIPTION: The ransomware cyberattack known as WannaCry infected hundreds of thousands of computers globally on Friday, but the malware was first detected in March and reported stolen from the United States National Security Agency a month later.

7. Screenshot of first search result when queried 'Bitcoin Blockchain' using PageRank

Q. Why some pages have higher PageRank values than others?

Ans: The PageRank algorithm computes the rank of a page by counting the number of links to a page to determine a rough estimate of how important the website is. In this assignment, I have created a graph using a list of edges that helps in determining the value and the rank of a page. These search results will follow a ranking order and will be different. The underlying assumption is that more important websites are likely to receive more links from other websites. The fact that the rank or weight of the page is determined by the number of links that point to it is the main reason that some pages have a higher page rank value than other pages. Also, the term frequencies are not taken into consideration in PageRank algorithm.

Table containing list of URLs of the top ten results produced by both ranking methods for each query:

Query: Bitcoin Blockchain	
Lucene	**Page Rank**
http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html	http://www.foxnews.com/
http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html	http://www.foxnews.com/tech/2018/03/15/canadian-ceo-arrested-in-us-on-charges-supplying-encrypted-phones-to-mexican-cartels.html
http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html	http://www.foxnews.com/category/tech/topics/computers.html
http://www.foxnews.com/politics/2018/02/07/arizona-might-allow-people-to-pay-taxes-via-bitcoin.html	http://www.foxnews.com/tech/2018/03/02/biggest-ddos-attack-on-record-hits-github.html
http://www.foxnews.com/tech/2018/01/24/hackers-steal-as-much-as-10-percent-new-cryptocurrency-funds.html	http://www.foxnews.com/tech/2016/02/18/los-angeles-hospital-paid-17g-ransom-to-hackers-who-disabled-computer-network.html
http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html	http://www.foxnews.com/tech/2017/05/15/ransomware-what-is-it.html
http://www.foxnews.com/tech/2018/03/01/lawsuit-alleges-bitcoin-pioneer-became-thief.html	http://www.foxnews.com/tech/2017/12/12/nintendo-switch-becomes-enormous-hit-sells-10m-units-in-under-9-months.html
http://www.foxnews.com/tech/2018/01/24/hackers-steal-as-much-as-10-percent-new-cryptocurrency-funds.html	http://www.foxnews.com/tech/2018/03/09/finding-phone-numbers-online-incomes-and-more-tech-q.html
http://www.foxnews.com/tech/2018/03/03/smartwatches-better-tv-reception-bitcoin-investments-and-more-tech-q.html	http://www.foxnews.com/tech/2018/02/04/tech-q-dueling-assistants-outsmarting-hackers-blocking-texts-and-more.html
http://www.foxnews.com/tech/2018/03/03/smartwatches-better-tv-reception-bitcoin-investments-and-more-tech-q.html	http://www.foxnews.com/tech/2017/05/15/what-is-wannacry-ransomware.html

Query: Stephen Hawking	
Lucene	**Page Rank**
http://www.foxnews.com/science/slideshow/2018/03/14/look-back-on-life-renowned-physicist-stephen-hawking.html	http://www.foxnews.com/entertainment.html
http://www.foxnews.com/science/slideshow/2018/03/14/look-back-on-life-renowned-physicist-stephen-hawking.html	http://www.foxnews.com/science.html
http://www.foxnews.com/science/2018/03/16/how-stephen-hawking-transformed-our-understanding-black-holes.html	http://www.foxnews.com/opinion.html
http://www.foxnews.com/science/2018/03/16/how-stephen-hawking-transformed-our-understanding-black-holes.html	http://www.foxnews.com/sports/2018/03/17/march-madness-2018-schedule-and-what-to-know.html
http://www.foxnews.com/science/2018/03/14/stephen-hawking-unlocked-universe-possibilities-nasa-says.html	http://www.foxnews.com/science/2018/03/14/stephen-hawking-famed-physicist-dead-at-76.html
http://www.foxnews.com/science/2018/03/14/stephen-hawking-unlocked-universe-possibilities-nasa-says.html	http://www.foxnews.com/science/2018/03/12/scientists-say-dream-unlimited-clean-energy-is-about-to-come-true.html
http://www.foxnews.com/science/2018/03/14/stephen-hawking-famed-physicist-dead-at-76.html	http://www.foxnews.com/world/slideshow/2018/01/19/week-in-pictures.html
http://www.foxnews.com/science/2018/03/14/stephen-hawking-famed-physicist-dead-at-76.html	http://www.foxnews.com/science/2018/03/15/texas-state-lawmaker-criticized-for-stephen-hawking-tweet-hours-after-physicist-s-death.html
http://www.foxnews.com/tech/2018/03/14/stephen-hawking-tech-execs-remember-legacy-famed-physicist.html	http://www.foxnews.com/tech/slideshow/2017/09/12/photos-apple-unveils-its-new-iphones.html
http://www.foxnews.com/tech/2018/03/14/stephen-hawking-tech-execs-remember-legacy-famed-physicist.html	http://www.foxnews.com/us/slideshow/2018/01/19/in-pictures-trumps-first-year-in-office.html
Query: Falcon Heavy	
Lucene	**Page Rank**
http://www.foxnews.com/science/2018/03/12/how-spacex-falcon-heavy-rocket-compares-to-elon-musks-other-powerful-spacecraft.html	http://www.foxnews.com/weather/your-weather/index.html

http://www.foxnews.com/science/2018/03/12/how-spacex-falcon-heavy-rocket-compares-to-elon-musks-other-powerful-spacecraft.html	http://www.foxnews.com/weather/2017/10/31/nfl-thursday-night-football-dry-weather-expected-as-bills-jets-collide-at/
http://www.foxnews.com/science/2018/02/06/spacex-falcon-heavy-rocket-launches-successfully.html	http://www.foxnews.com/weather/index.html
http://www.foxnews.com/science/2018/03/12/how-spacex-falcon-heavy-rocket-compares-to-elon-musks-other-powerful-spacecraft.html	http://www.foxnews.com/weather/2017/10/29/reports-damaging-winds-flooding-leads-to-dangerous-conditions/
http://www.foxnews.com/science/2018/03/12/how-spacex-falcon-heavy-rocket-compares-to-elon-musks-other-powerful-spacecraft.html	http://www.foxnews.com/weather/2017/10/29/flooding-rain-damaging-winds-to-wallop-northeastern-us-into-monday/
http://www.foxnews.com/science/2018/03/12/how-spacex-falcon-heavy-rocket-compares-to-elon-musks-other-powerful-spacecraft.html	http://www.foxnews.com/weather/2017/10/30/blustery-conditions-in-store-for-trick-or-treaters-in-northeastern-central-us/
http://www.foxnews.com/science/2018/02/06/spacex-falcon-heavy-rocket-launches-successfully.html	http://www.foxnews.com/us/2018/03/18/firefighters-remains-found-in-river-nearly-2-weeks-after-vehicle-plunged-report.html
http://www.foxnews.com/science/2018/02/06/spacex-falcon-heavy-launch-preview-what-when-and-why.html	http://www.foxnews.com/opinion/2018/03/17/one-word-my-daughter-whispered-to-me-that-caught-me-by-surprise.html
http://www.foxnews.com/science/2018/02/06/spacex-falcon-heavy-rocket-launches-successfully.html	http://www.foxnews.com/food-drink/2018/03/16/5-st-patricks-day-cocktails-that-dont-involve-whiskey.html
http://www.foxnews.com/science/2018/02/07/elon-musk-has-launched-falcon-heavy-but-how-long-does-it-take-to-get-to-mars.html	http://www.foxnews.com/world/slideshow/2018/02/09/week-in-pictures.html
Query: Syrian War	
Lucene	**Page Rank**
http://www.foxnews.com/world/2018/03/15/syria-marks-7-years-war-hundreds-leave-besieged-enclave.html	http://www.foxnews.com/weather/your-weather/index.html

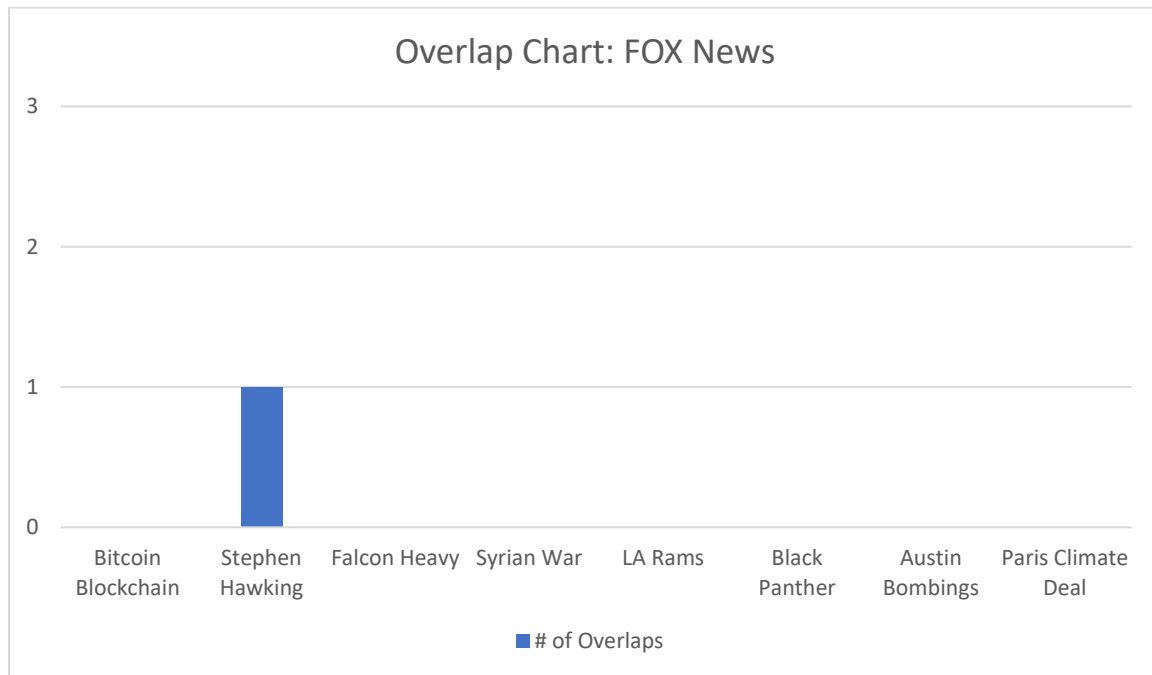|	
http://www.foxnews.com/world/2018/03/15/syria-marks-7-years-war-hundreds-leave-besieged-enclave.html	http://www.foxnews.com/weather/2017/11/01/winds-from-north-korea-nuclear-test-site-may-send-radiation-toward-japan/
http://www.foxnews.com/world/2018/03/15/syria-marks-7-years-war-hundreds-leave-besieged-enclave.html	http://www.foxnews.com/trending
http://www.foxnews.com/world/2018/03/15/syria-marks-7-years-war-hundreds-leave-besieged-enclave.html	http://www.foxnews.com/weather/index.html
http://www.foxnews.com/world/2018/03/15/syria-marks-7-years-war-hundreds-leave-besieged-enclave.html	http://www.foxnews.com/us/2018/03/17/adrian-lamo-hacker-who-turned-in-chelsea-manning-to-fbi-found-dead.html
http://www.foxnews.com/opinion/2018/03/16/rep-adam-kinzinger-it-s-for-us-to-lead-on-syria-failure-to-act-is-failure-by-all-us.html	http://www.foxnews.com/politics/2018/03/17/trump-team-zeroes-in-on-fbi-russia-probe-in-wake-deputy-director-mccabes-firing.html
http://www.foxnews.com/opinion/2018/03/16/rep-adam-kinzinger-it-s-for-us-to-lead-on-syria-failure-to-act-is-failure-by-all-us.html	http://www.foxnews.com/politics/2018/03/17/fired-mccabe-kept-notes-on-trump-as-comey-did-and-gave-them-to-special-counsel-mueller.html
http://www.foxnews.com/politics/2017/03/10/new-trump-travel-ban-cant-be-enforced-on-syrian-family-trying-to-flee-to-wisconsin-judge-says.html	http://www.foxnews.com/weather/2017/10/30/november-to-take-on-role-quick-change-artist-in-midwestern-northeastern-us/
http://www.foxnews.com/opinion/2018/03/16/rep-adam-kinzinger-it-s-for-us-to-lead-on-syria-failure-to-act-is-failure-by-all-us.html	http://www.foxnews.com/opinion/2018/03/17/andrew-mccabes-firing-was-justified-and-right-thing-to-do.html
http://www.foxnews.com/world/2017/04/08/in-istanbul-little-syria-refugees-want-more-from-us.html	http://www.foxnews.com/world/2018/03/18/southeast-asia-leaders-back-sanctions-against-north-korea.html
Query: LA Rams	
Lucene	**Page Rank**
http://www.foxnews.com/sports/2018/01/24/rams-add-former-ucla-offensive-coordinator-jedd-fisch-to-staff.html	http://www.foxnews.com/
http://www.foxnews.com/sports/2018/01/24/rams-add-former-ucla-offensive-coordinator-jedd-fisch-to-staff.html	http://www.foxnews.com/tech/2018/03/16/your-personal-data-may-be-on-dark-web-what-need-to-know.html

http://www.foxnews.com/sports/2017/01/25/jim-kelly-draws-on-experience-in-campaign-against-cancer.html	http://www.foxnews.com/on-air/fox-and-friends-first
http://www.foxnews.com/sports/2018/01/24/rams-add-former-ucla-offensive-coordinator-jedd-fisch-to-staff.html	http://www.foxnews.com/lifestyle.html
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Overlaps:

Overlap Chart: FOX News

There is just 1 overlap between the two ranking algorithms for the query *"Stephen Hawking"* and no overlap for rest of the queries.