The University of Texas at Dallas
CS 6322
Information Retrieval
Spring 2020
Class Project Report
Project TITLE: Search engine for Olympic Games
TEAM 08

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1. The Problem (5 points): Generate a search engine for Olympic Games

The goal of the project was to develop a simple search engine to show olympic games related information. To that end, we crawled the web to build an index of nearly 102920 web pages related to the Olympics, clustered the webpage contents and applied PageRank and HITS algorithms to get relevant results, carried out different types of query expansion techniques and observed their effects on relevance.

Following is overview of the entire project
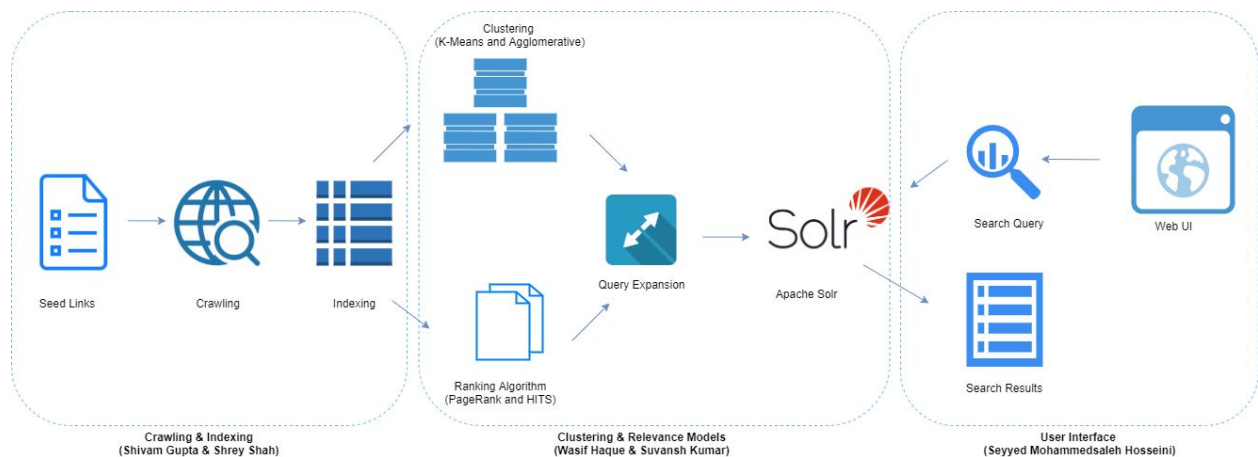
One challenge we faced was using Scrapy for web crawling which turned out to be very time consuming and was not yielding good results. So resolved by moving over to Apache Nutz for crawling and indexing which made the whole process smoother.

Another challenge was that, initially we were using clustering to first cluster the results based by assigning a cluster for a given query. This approach seemed infeasible as it was not giving us good results. We instead opted to use Solr's search results using PageRank and HITS score and then refined them further using clustering to get better results.

Shivam Gupta(sxg190040)

2. Crawling (45 points):

In the beginning, We started crawling from the scrapy library of python with the implementation of the Breath first traversal(BFS) and it was giving good results, we were able to crawl around 1 million web pages, but there were certain issues with scrapy like it was giving us multiple duplicate links and it was giving certain irrelevant links. Another issue with scrapy was that it was quite difficult to integrate this crawling with Indexing and relevance models. So We explored a lot and figured out a famous Crawler named as " Apache Nutch" which is coded entirely in the **JAVA** programming language and is so fast

So we gathered around 76 URLs relevant to the Olympics from official websites to sports channels from different sources. ***Seed links*** are the initial source from where the URLs are going to crawl as the beginning point and create a web graph. We used about *76 seed links (Web links)* in out Crawling process mentioned as follows:

'**https://www.olympic.org**'
'**https://tokyo2020.org/en/**'
'**https://www.nbcolympics.com/**'
'**https://www.teamusa.org/**'
'**https://www.olympicchannel.com/en/**'
'**https://www.loc.gov/rr/main/olympics/internet.html**'
'**https://www.specialolympics.org/**'
'**https://www.soiowa.org/**'
'**https://www.2022specialolympicsusagames.org/**',
'**https://www.espn.com/olympics/**',
'**https://www.nytimes.com/section/sports/olympics**',
'**https://www.britannica.com/sports/Origins-of-the-Olympic-Winter-Games**',
'**https://www.bbc.com/sport/olympics/rio-2016**',
'**https://www.cbssports.com/olympics/**',
'**https://www.foxsports.com/olympics**',
'**http://en.beijing2008.cn/en/**','**https://www.abc.net.au/news/rio-olympics-2016/**',
'**https://www.worldathletics.org**', '**https://www.olympic.org/vancouver-2010**,
'**https://www.olympic.org/london-2012**',
'**https://www.cbc.ca/sports/olympics**',
'**https://sports.yahoo.com/olympics/pyeongchang-2018/**',
'**https://www.factmonster.com/features/olympics**',
'**https://olympics.nbcsports.com/**',

'https://www.foxnews.com/category/sports/olympics',
'https://www.livescience.com/26654-olympia.html',
'https://www.olympicchannel.com/en/sports/'
'https://www.sciencekids.co.nz/sciencefacts/sports/summerolympics.html',
'https://www.sciencekids.co.nz/sciencefacts/sports/winterolympics.html'
'https://www.loc.gov/rr/main/olympics/dates.html',
'https://time.com/5689792/2020-tokyo-olympics-when-where/'
,'https://www.timeanddate.com/events/summer-olympic-games.html',
'https://web.archive.org/web/20081009043255/
http://www.sok.se/inenglish/stockholmmelbourne1956.4.18ea16851076df63622800011093.html',
'https://sok.se/om-webbplatsen/webbkarta.html'
'https://www.paralympic.org/powerlifting'
'https://web.archive.org/web/20110429094019/
http://multimedia.olympic.org/pdf/en_report_1138.pdf',
'https://web.archive.org/web/20090324234949/
http://multimedia.olympic.org/pdf/en_report_1303.pdf',
'https://olympics.fandom.com/wiki/Athens_2004',
'http://www.frbsf.org/economic-research/files/wp09-06bk.pdf',
'https://web.archive.org/web/20070927021042/
http://www.fasterskier.com/racing4278.html'
https://www.infoplease.com/sports/winter-olympics-through-years/1972-olympics
https://utah.com/olympics
https://www.britannica.com/event/Salt-Lake-City-2002-Olympic-Winter-Games
https://olympic.ca/
http://www.olympic.org.nz/
https://www.obs.tv/home
https://usa.visa.com/about-visa/sponsorships-promotions/olympics-partnership.html
https://usopm.org/
https://www.iihf.com/en/static/5478/olympic
https://www.cityofml.com/430/Special-Olympics
https://en.wikipedia.org/wiki/Lists_of_Olympic_medalists
https://en.wikipedia.org/wiki/All-time_Olympic_Games_medal_table
https://www.olympicchannel.com/en/stories/features/detail/india-olympics-medals/
https://www.ancient.eu/Olympic_Games/
https://www.sotx.org/
https://aausports.org/
https://www.olympic.ind.in/
http://en.olympic.cn/
https://www.olympics.com.au/
https://www.teamgb.com/
https://www.paris2024.org/en/
https://swe2021.org/

https://www.sports-reference.com/olympics/
https://www.rsxclass.org/events/olympic-games/
http://rio2016.fivb.com/en/volleyball/media/volleyballhistory
https://www.usahockey.com/
https://www.infoplease.com/olympic-athletes

We also handled the RLs(similar content but URL) are optionally marked in the CrawlDb and are the deleted afterwards during the process of in the indexing via Apache Solr, So we removes the duplicate URls by following ways:

MapReduce "dedup":

- *Map*: Identities hashmap(dictionary) where keys are digests and values are CrawlDatum records
- *Reduce*: CrawlDatums with the same digest are marked (except one of them) as duplicates. There are multiple heuristics available to choose from of the item which is not marked as duplicate - the one with the shortest URL, fetched most recently, or with the highest score.

So We extracted and installed Apache Nutch on csgrads1.utdallas.edu UTD Linux server and gave the JAVA path variables over there as the Nutch is completely written in java, so that was really important to run our crawler

Crawling in *Apache Nutch* was done into the following steps:

- **Injecting** seed URLs into Nutch crawl database. Nutch Crawl Database contains all the links that have been parsed or is to be parsed by Nutch.
- *Then generating segments* for the list of injected URLs. This step ensures whether the link given for crawling has already been parsed or not and if it follows the regex of allowed URLs.
- Nutch then starts to crawl the links in the segment .In this step Nutch parses the webpage to look for the contents as well as any outgoing URLs in the page.

4) After Nutch has crawled a set of URLs those URLs are merged with the **crawl database**. For each URL parse Nutch makes an entry to the link database of the URLs a particular URL is referring to.

We did the crawling in *segmentation* to make sure that if any error occurs in the middle we need not to start the crawling process from the starting seed links. We initially injected *76 seed links in Nutch*. We took segments of 1000 URLs to be crawled at a time to ensure better crawled data.

Apache Nutch crawling data contains 3 folder:

1) **CrawlDb** - It contains all the URLs which are parsed by the Nutch.

2) **LinkDB** - It contains for every URL(link) outgoing and the incoming URLs.

3) **Segment** - It contains the list of URLs to be crawled or being crawled.In order to pass hyperlink information, I gave read permissions to all of the data which we collected and explained the crawled output of Nutch in order to provide Apache Solr for the creation of the indexes so that they would be

able to read the _data efficiently_ and create the indexes.Nutch commands which we used to crawl on UTD Linux server(First loading the top 1000 Links, then declaring a variable($s2) to put the crawled segment into a variable, then fetching the links and the contents, then parsing those data to $s2 and updating the Database with the crawled data)

```
 bin/nutch generate crawl/crawldb crawl/segments -topN 1000
```

First loading the top 1000 Links

```
s2=`ls -d crawl/segments/2* | tail -1`x
```

declaring a variable($s2) to put the crawled segment into a variable

```
bin/nutch fetch $s2
```

fetching the links and the contents

```
bin/nutch parse $s2
```

then parsing those data to $s2

```
bin/nutch updatedb crawl/crawldb $s2

## and updating the Database with the crawled data
```

/crawl -i -D Solr.server.URL=http://localhost:8983/Solr/ URLs/ TestCrawl/ 3

crawl [-i|--index] [D "key=value"] <Seed Dir> <Crawl Dir> <Num Rounds>

-i|- -   index Indexes crawl results into a configured indexer

-D   A Java property to pass to Nutch calls

Seed Directory   Directory in which to look for a seeds file(in a text file(seed.txt))

Crawl Dir Directory where the crawl/link/segments dirs are saved

Num Rounds   The number of rounds to run crawling for

We used Apache Solr to index documents crawled by Nutch .We used one of the Nutch commands mentioned above which crawls and directly sends the contents parsed from URL by Nutch to Solr for indexing. In order to allow Nutch to directly send its contents to Solr we have to change Solr#39;s schema.xml for the collection we were using in Solr. We have directly supplied the crawled contents from APache Nutch to Apache Solr for indexing purposes.

In the above command -i tells Nutch to send it's parsed content to the assigned indexer which is Solr in our case.

To provide URLs for PageRank and HITS algorithm we generated a dump out of linkdb of Nutch.

We also implemented a Python program to read the above dump and generate for each URL parse a URL id and to create a graph from it using the networkx library from python.

Some screenshots during Crawling on CSGrad UTD Linux Server

```
csgrads1.utdallas.edu - PuTTY                                                    —   □   ×
Parsed (2ms):https://www.sports-reference.com/olympics/summer/1972/SWI/mens-4-x-100-metres-freestyle-relay.html
Parsed (5ms):https://www.sports-reference.com/olympics/summer/1976/ATH/mens-100-metres.html
Parsed (3ms):https://www.sports-reference.com/olympics/summer/1992/SWI/mens-4-x-100-metres-freestyle-relay.html
Parsed (3ms):https://www.sports-reference.com/olympics/summer/1996/GYM/
Parsed (5ms):https://www.sports-reference.com/olympics/winter/1980/SSK/mens-10000-metres.html
Parsed (4ms):https://www.sports-reference.com/olympics/winter/1980/SSK/mens-1500-metres.html
Parsed (4ms):https://www.sports-reference.com/olympics/winter/1980/SSK/mens-5000-metres.html
Parsed (4ms):https://www.sports-reference.com/olympics/winter/1980/SSK/womens-1000-metres.html
Parsed (3ms):https://www.sports-reference.com/olympics/winter/1980/SSK/womens-1500-metres.html
Parsed (2ms):https://www.sports-reference.com/olympics/winter/1994/CCS/
Parsed (7ms):https://www.sports-reference.com/olympics/winter/1998/BIA/mens-10-kilometres-sprint.html
Parsed (7ms):https://www.sports-reference.com/olympics/winter/2002/BIA/mens-10-kilometres-sprint.html
Parsed (11ms):https://www.sports-reference.com/olympics/winter/2002/BIA/mens-20-kilometres.html
Parsed (3ms):https://www.sports-reference.com/olympics/winter/2002/BIA/mens-4-x-7_5-kilometres-relay.html
Parsed (8ms):https://www.sports-reference.com/olympics/winter/2006/BIA/mens-10-kilometres-sprint.html
Parsed (7ms):https://www.sports-reference.com/olympics/winter/2006/BIA/mens-12_5-kilometres-pursuit.html
Parsed (4ms):https://www.sports-reference.com/olympics/winter/2006/BIA/mens-15-kilometres-mass-start.html
Parsed (10ms):https://www.sports-reference.com/olympics/winter/2006/BIA/mens-20-kilometres.html
Parsed (3ms):https://www.sports-reference.com/olympics/winter/2006/BIA/mens-4-x-7_5-kilometres-relay.html
Parsed (9ms):https://www.teamgb.com/summer-sports/cycling-track
Parsed (8ms):https://www.teamgb.com/summer-sports/diving
Parsed (7ms):https://www.teamgb.com/summer-sports/hockey
Parsed (7ms):https://www.teamgb.com/summer-sports/tennis
Parsed (15ms):https://www.texasroadhouse.com/gift-cards
Parsed (2ms):https://www.usahockeyintelligym.com/members/reset
Parsed (5ms):https://www.warrior.com/on/demandware.store/Sites-warrior_us-Site/en_US/Stores-Locator
Parsed (35ms):https://www.youtube.com/channel/UC6yKylYBunWCgqY4s-mqZCg
Parsed (24ms):https://www.youtube.com/channel/UCzR-rom72PHN9Zg7RML9EbA
Parsed (1ms):https://www.youtube.com/embed/ShM35jYeptY
Parsed (36ms):https://www.youtube.com/user/JimmyKimmelLive
Parsed (42ms):https://www.youtube.com/user/YouTube
Parsed (3ms):https://www2.deloitte.com/etc/designs/dcom/assets/images/my-deloitte/my-Deloitte-logo-rev.svg
ParseSegment: finished at 2020-04-27 06:46:26, elapsed: 00:00:29
{csgrads1:~/IR_Project/apache-nutch-1.16} bin/nutch updatedb crawl/crawldb $s2
CrawlDb update: starting at 2020-04-27 06:46:39
CrawlDb update: db: crawl/crawldb
CrawlDb update: segments: [crawl/segments/20200427061909]
CrawlDb update: additions allowed: true
CrawlDb update: URL normalizing: false
CrawlDb update: URL filtering: false
CrawlDb update: 404 purging: false
CrawlDb update: Merging segment data into db.
CrawlDb update: finished at 2020-04-27 06:46:44, elapsed: 00:00:04
{csgrads1:~/IR_Project/apache-nutch-1.16}
```

We also created a webgraph which contains the information about Inlinks and Outlinks which helps in calculating the HITS (Hyperlink-Induced Topic Search)

Web graph information is as follows:

Total Number of links = 91441

Total Number of nodes = 25587

In the end, We generated like *102920 webpages*. These files created via Apache were further used for Indexing and building Relevance model

3. Indexing and Relevance

Indexing

We have used Apache Solr for indexing the crawled pages. The following command has been used to create the index of crawled pages in Solr with the help of nutch:

bin/nutch index crawl/crawldb/ -linkdb crawl/linkdb -dir crawl/segments/ -filter -normalize -

deleteGone

bin/nutch is the binary of Apache nutch. The index command takes the content crawldb and passes it to IndexWriter plugins which has Solr set as the indexer.

Crawl data of nutch is made up of three components

1) **CrawlDb** - It contains all the link parsed by the Nutch.

2) **LinkDB** - It contains outgoing and the incoming URLs for each webpage.

3) **Segment** - It contains the list of URLs to be crawled or being crawled for incremental crawl.

Index Creation Flow Diagram
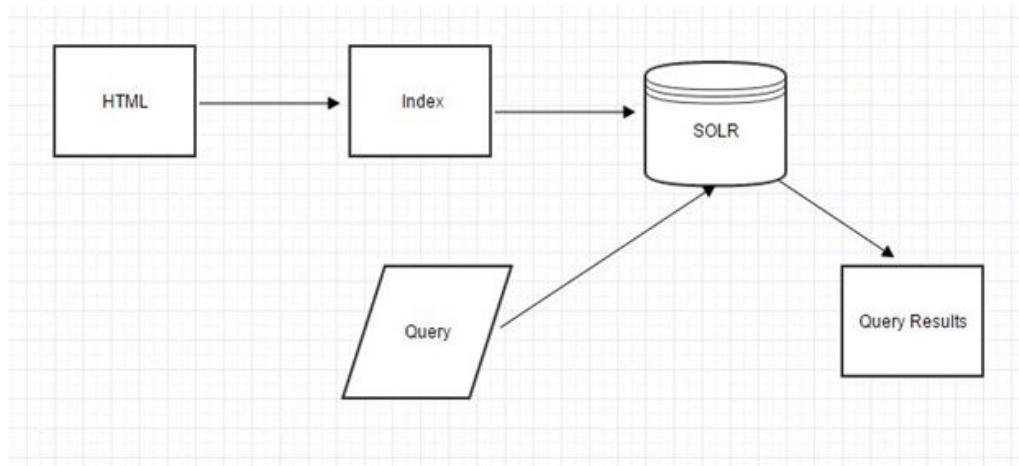
Webgraph and Statistics

We have used nutch command to create the webgraph of all the crawled webpages.

bin/nutch webgraph -segmentDir crawl/segments/ -webgraphdb crawl/webgraphdb

The webgraph command of nutch takes multiple segments to process and requires an output

directory in which to place the completed web graph components. The webgraph creates three

different components: an inlink database, an outlink database and a node database. The inlink

database is a listing of url and all of its inlinks. The outlink database is a listing of url and all of its

outlinks. The node database is a listing of url with node meta information including the number of

inlinks and outlinks.

Statistics

Total Number of links = 91441

Total Number of nodes = 25587

The largest number of ingoing links = 5674

The largest number of outgoing links = 205

Web graph information connected to index

While creating index in Solr, we have run the LinkRank program of nutch to perform an iterative link analysis with the webgraph. LinkRank is a pagerank-like link analysis program that converges to stable global scores for each url. The LinkRank program starts with a common score for all urls. It then creates a global score for each url based on the number of incoming links and the scores for those links and the number of outgoing links from the page.

Relevance Models

Vector Space Relevance model

Solr provides tf-idf based relevance model to score the webpages and we made use of this model as vector space relevance model. In vector space relevance model, documents and queries are both vectors. Similarity of a document vector to a query vector can be computed by taking the cosine of the angle between them. Cosine similarity measure has been used to get the similarity between document and query. This scoring model depends on number of factors –

Term frequency - The frequency with which a term appears in a document. Given a search query,

the higher the term frequency, the higher the document score.

Inverse document frequency - The rarer a term is across all documents in the index, the higher its

contribution to the score.

Tf-idf weighting scheme has been used to create the relevance model. In this weighting scheme,

$W_{d,t} = tf_{d,t} \times idf_t$

Tf-idf weighting scheme is the most common weighting scheme in vector space relevance model.

Page Rank

To develop the relevance model based on Page Ranking, we used inbuilt nutch command. The

damping factor used is 0.80. Following are the steps we followed in order to apply PageRank scores

into crawled database so that query results will display web pages in the descending order of page

ranking values –

1. Create a web graph from the set of URLS fetched by the crawler

bin/nutch webgraph -segmentDir crawl/segments/ -webgraphdb crawl/webgraphdb

2. Run PageRank algorithm iteratively until the score converges

bin/nutch linkrank -webgraphdb crawl/webgraphdb/

3. Update the page rank score into the crawled database

bin/nutch scoreupdater -crawldb crawl/crawldb - webgraphdb crawl/webgraphdb/

4. Finally, index the updated crawled database using Solr and nutch command:

bin/nutch index crawl/crawldb -linkdb crawl/linkdb -dir crawl/segments/

HITS (Hyperlink Induced Topic Search)

For the HITS score, we created our own python program to generate the authority and the hub score in python. HITS uses hubs and authorities to define a recursive relationship between webpages. Given a query to a Search Engine, the set of highly relevant web pages are called **Roots**. They are potential **Authorities**. Pages which are not very relevant but point to pages in the Root are called **Hubs**. Thus, an Authority is a page that many hubs link to whereas a Hub is a page that links to many authorities.

We used the **networkx library** to create the graph through the inlinks and outlinks information of all the nodes (urls) and ran the hits algorithm on the graph to generate the hub and the authority scores. To get these inlinks, we used nutch and generated a dump of the all the inlinks of crawled pages. With the inlinks dictionary, we created the outlinks as well. Based on the query provided by the user, root set of web pages are collected based on page rank results. The root set is converted to a base set by adding out link and inlinks of the root set. After that, HIT score calculation is done by our python program and based on maximum authority score, relevant web pages are sorted and returned to the User Interface for display.

Among the webpages we crawled,

1. Highest hub score was assigned to http://www.sports.cn/yjsy/index.html ,score – 0.0356845

2. Highest authority score was assigned to: http://www.sports.cn/yjsy/index.html ,score – 0.0625465

Topic based page ranking

For the purpose of testing Topic based page ranking, we have chosen 2 topics among countries:

1. swimming gold medals

2. opening ceremony

The results for **swimming gold medals** are as follows from our search engine

"url": https://www.olympics.com.au/resources/articles/australian-olympic-team-statisticstrivia/

"title": "Australian Olympic Team Stati... | Australian Olympic Committee",

"score":0.38731545

"url":https://www.sports-reference.com/olympics/athletes/ph/michael-phelps-1.html

"title": "Michael Phelps Bio, Stats, and Results | Olympics at Sports-Reference.com"

"score":0.36531512

"url":https://www.sports-reference.com/olympics/athletes/bi/matt-biondi-1.html

"title": "Matt Biondi Bio, Stats, and Results | Olympics at Sports-Reference.com"

"score":0.35831462

"url":https://usopm.org/erin-popovich/

"title": "Erin Popovich | Swimming | Olympic Hall of Fame"

"score":0.35756231

The results for **opening ceremony** are as follows from our search engine:

"url":"http://en.olympic.cn/news/olympic_news/2020-02-07/2359369.html"

"title": "Tokyo Olympics opening ceremony nearly 80% complete, says director Nomura - Official Website of the "

"score":0.38856932

"url":https://en.wikipedia.org/wiki/2018_Winter_Olympics_opening_ceremony

"title":"2018 Winter Olympics opening ceremony - Wikipedia"

"score":0.37735542

"url":https://www.olympic.org/opening-ceremonies

"title":"The Opening Ceremonies of the Olympic Games - Olympic News"

"score":0.37232515

"url":https://time.com/5141561/order-countries-marched-in-at-winter-olympics-opening-ceremony/

"title":"Order of Countries in Olympics Opening Ceremony | Time"

"score":0.369356825

Collaboration with UI and test relevance models results

In collaboration with the person responsible for UI and clustering, we tested 20 queries and observed that the results of the query gets better after applying HIT score and clustering.

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4. User interface and comparisons with Google and Bing (45 points): written

The front end is rendered using HTML, CSS, and JQuery, and it is powered by PHP in the backend. Bootstrap CSS library is used to design the page layout.

The search functionality enables the user to query for Olympics. We have shown the result of the query in six different tabs on the same page: the first tab contains the documents retrieved by vector similarity and then arranged based on the page rank. The second tab contains the results after using three different query expansion methods. There are three navigation tabs under the Query Expansion tab, each for showing the expanded query and the search results using that expanded query. The third tab shows the search results when clustering is used, and the fourth tab has the results for vector space model. Finally, the Google and Bing results are shown in tabs 5 and 6, respectively.

Getting Google and Bing Results:

We used API calls to fetch Google and Bing search results. For Google, the setup was done using the following link:

https://cse.google.com/cse/all

, and the call is made using the following link:

https://www.googleapis.com/customsearch/v1?key={$APIKey}&cx=$searchEngineID&q={$query}

For Bing, the setup was done using the following link:

https://docs.microsoft.com/en-us/azure/cognitive-services/bing-custom-search/quick-start

, and the call is made using the following link:

https://api.cognitive.microsoft.com/bing/v7.0/search?q={$query}&count={$count}&offset={$offset}&mkt={$mkt}& safesearch={$safesearch}

Since a GET request with the header "Ocp-Apim-Subscription-Key: {$subscriptionKey}" must be sent to the Bing server, I used curl library in PHP to do so.

An API is written by Shrey which takes a request in the following format:

http://127.0.0.1:5000//api/v1/indexer?query={$query}&type={$type}

in which $query is the query and $type shows what type of answer is needed (for instance it can be "vector" to get the vector space model results or "clustering" to get the clustering results).

The following steps are performed when user searches for a query:

1. Read the query given by the user

2. Call Google API and BING API to fetch the results from Google and Bing, respectively

3. Send different requests to the API written by Shrey and get the results for page rank, query expansion, clustering, HITS, and vector space.

4. Render the json results into HTML

5. Display all the results in different tabs

More than 20 queries were tested to evaluate then. 10 queries were tested with collaboration with Shrey who was in charge of relevance models, and the rest were done on my own.

Clustering is done by Wasif. The results from clustering are fetched using the API that Shrey has written.

By comparing our results to Google and Bing, we can see that, in some cases, our methods are giving results that are related to Olympics, whereas Google and Bing do not do so. This happens, for instance, for the query "Usain Bolt" as it is also visible in the screenshots. However, in most of the cases, our methods have subjectively the same performance as Google and Bing. For instance, for the query

"Lionel Messi", our methods do not show any results related to Olympics. This is probably a problem related to the crawler since we only crawled around 100,000 pages.

Seyyed MohammadSaleh Hosseini (sxh175430) – User Interface

As mentioned before, the clustering results are fetched using the API in a json file, and then, they are shown in "Clustering" tab.

We have decided to demonstrate the results for which our system is giving better results than Google and Bing as well as results for some queries for which our results are the same as Google and Bing.

Some screenshots of the system follow:
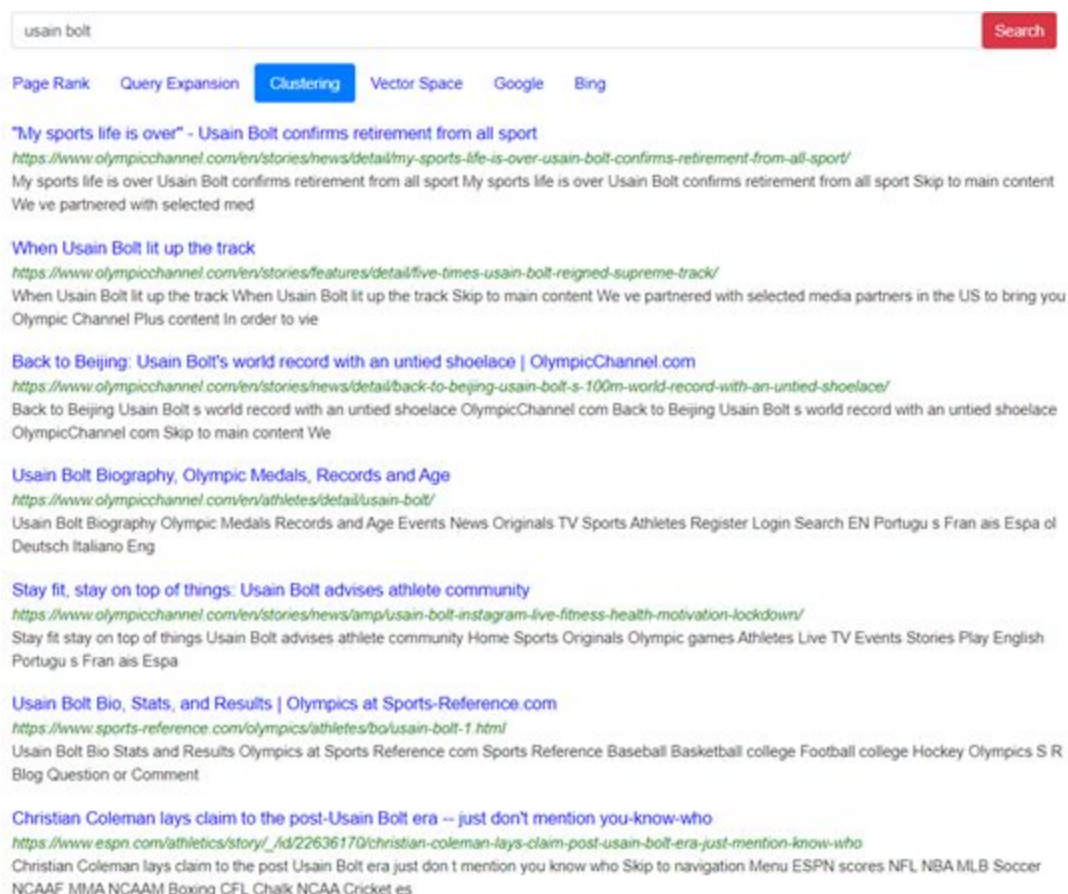
usain bolt

Search

Page Rank   Query Expansion   Clustering   Vector Space   Google   Bing

Total results: 8710000
Search Time: 0.28 seconds

Usain Bolt - Wikipedia
https://en.wikipedia.org/wiki/Usain_Bolt
Usain St Leo **Bolt**, OJ, CD is a Jamaican former sprinter. He is a world record
holder in the 100 metres, 200 metres and 4 × 100 metres relay. Owing to his ...

Usain Bolt
http://usainbolt.com/
29th November 2019 – **Usain Bolt** Presents: Immortal Riddim Medley featuring
songs from Vybz Kartel, Masicka, Munga Honorable, Zuzu, Ding Dong &
Demarco.

Usain St. Leo Bolt (@**usainbolt**) | Twitter
https://twitter.com/usainbolt?lang=en
The latest Tweets from Usain St. Leo Bolt (@**usainbolt**). Anything is possible I don
't think limits. Kingston, Jamaica.

Usain St.Leo Bolt (@**usainbolt**) • Instagram photos and videos
https://www.instagram.com/usainbolt/?hl=en
9.5m Followers, 210 Following, 1392 Posts - See Instagram photos and videos
from Usain St.Leo Bolt (@**usainbolt**)

Usain Bolt - Home | Facebook
https://www.facebook.com/usainbolt/
Usain Bolt, Kingston, Jamaica. 18414807 likes · 15210 talking about this. The
Fastest Man in the World has the records for the 100m (9.58) and 200m...

Usain BOLT - Olympic Athletics | Jamaica
https://www.olympic.org/usain-bolt
Usain Bolt enhanced his already legendary Olympic status with an
unprecedented third consecutive 100m, 200m and 4x100m triple at Rio 2016, a
feat that may ...

Evolution of **Usain Bolt's** Speed | 2004 2017 - YouTube

usain bolt | Search

Page Rank   Query Expansion   Clustering   Vector Space   Google   **Bing**

Total results: 5350000

Usain Bolt - Wikipedia
https://en.wikipedia.org/wiki/Usain_Bolt
Usain St Leo Bolt, OJ, CD (/ˈjuːseɪn/; born 21 August 1986) is a Jamaican former sprinter.He is a world record holder in the 100 metres, 200 metres and 4 × 100 metres relay.Owing to his achievements and dominance in sprint competition, he is widely considered to be the greatest sprinter of all time.

Usain Bolt
http://usainbolt.com/
Usain Bolt Foundation refurbishes school ground and hands over computer equipment to schools in Trelawny January 29, 2020. 28th January 2020 – Seven schools in the parish of Trelawny are to benefit from the donation of computer equipment through the Usain Bolt Foundation (UBF).

Usain Bolt | Biography, Medals, & Facts | Britannica
https://www.britannica.com/biography/Usain-Bolt
Usain Bolt, in full Usain St. Leo Bolt, (born August 21, 1986, Montego Bay, Jamaica), Jamaican sprinter who won gold medals in the 100-metre and 200-metre races in an unprecedented three straight Olympic Games and is widely considered the greatest sprinter of all time.

Usain Bolt | Biography
http://usainbolt.com/bio/
The World's Fastest Man. Arguably the most naturally gifted athlete the world has ever seen, Usain St Leo Bolt, created history at the 2016 Olympic Games in Rio when he achieved the 'Triple Triple', three gold medals at three consecutive Olympic Games.

Usain Bolt - Record, Speed & Life - Biography
https://www.biography.com/athlete/usain-bolt
Usain Bolt is a Jamaican runner and Olympic legend who has been called "the fastest man alive" for smashing world records and winning 8 gold medals as a reigning champion at the 2008, 2012 and ...

Usain St.Leo Bolt (@usainbolt) • Instagram photos and videos
https://www.instagram.com/usainbolt/
9.5m Followers, 209 Following, 1,392 Posts - See Instagram photos and videos from Usain St.Leo Bolt (@usainbolt)

Coronavirus: Usain Bolt has the best 'social distancing' photo
https://nypost.com/2020/04/13/coronavirus-usain-bolt-has-the-best-social-distancing-photo/
Eight-time Olympic gold medal sprinter Usain Bolt is encouraging people to social distance by showing off how he's been practicing the cautionary act since the 2008 Beijing Olympics. Bolt took ...

michael phelps medal gold

Search

Page Rank | Query Expansion | Clustering | Vector Space | Google | Bing

United States Swimming at the 2004 Athina Summer Games | Olympics at Sports-Reference.com
https://www.sports-reference.com/olympics/countries/USA/summer/2004/SWI/
United States Swimming at the Athina Summer Games Olympics at Sports Reference com Sports Reference Baseball Basketball college Football college Hockey Olympics S R Blog Q

United States Swimming at the 2008 Beijing Summer Games | Olympics at Sports-Reference.com
https://www.sports-reference.com/olympics/countries/USA/summer/2008/SWI/
United States Swimming at the Beijing Summer Games Olympics at Sports Reference com Sports Reference Baseball Basketball college Football college Hockey Olympics S R Blog

Michael Phelps celebrates winning his 23rd Olympic gold medal - ABC News (Australian Broadcasting Co
https://www.abc.net.au/news/2016-08-22/michael-phelps-celebrates-winning-his-23rd-olympic-gold-medal/7770856
Michael Phelps celebrates winning his rd Olympic gold medal ABC News Australian Broadcasting Corporation ABC Home Open Sites menu ABC Home News iview TV Radio Kids Shop More Search Australia Wea

Rio 2016: Michael Phelps brings down the curtain with 23rd Olympic gold in 4x100m medley relay - Rio
https://www.abc.net.au/news/2016-08-14/michael-phelps-brings-down-the-curtain-with-23rd-olympic-gold/7733204
Rio Michael Phelps brings down the curtain with rd Olympic gold in x m medley relay Rio Olympics Australian Broadcasting Corporation ABC Home Open Sites menu ABC Home News iview TV

Michael PHELPS - Olympic Swimming | United States of America
https://www.olympic.org/michael-phelps
Michael PHELPS Olympic Swimming United States of America Javascript must be enabled for the correct page display skip to content Menu Olympic Games Olympic Games Olympic Winter Games Youth Olympic

United States Swimming | Olympics at Sports-Reference.com
https://www.sports-reference.com/olympics/countries/USA/summer/SWI/
United States Swimming Olympics at Sports Reference com Sports Reference Baseball Basketball college Football college Hockey Olympics S R Blog Question or Comment A Notice Abo

Swimming at the 2012 London Summer Games | Olympics at Sports-Reference.com
https://www.sports-reference.com/olympics/summer/2012/SWI/
Swimming at the London Summer Games Olympics at Sports Reference com Sports Reference Baseball Basketball college Football college Hockey Olympics S R Blog Question or Com

michael phelps medal gold   [Search]

Page Rank   Query Expansion   Clustering   Vector Space   **Google**   Bing

Total results: 2240000
Search Time: 0.30 seconds

Michael Phelps - Wikipedia
https://en.wikipedia.org/wiki/Michael_Phelps
This fourth **gold medal** was his tenth, and made him the all-time leader for most
Olympic **gold medals** won by an individual in ...

Full list of every Olympic **medal Michael Phelps** has won
https://www.usatoday.com/story/sports/olympics/rio-2016/2016/08/07/michael-phelps-medals/88361712/
Aug 7, 2016 **...** The most decorated athlete in Olympic history, American swimmer **Michael**
Phelps finished his career with 23 **gold medals** and 28 overall.

Michael Phelps - All EIGHT **Gold Medal** Races at Beijing 2008 ...
https://www.youtube.com/watch?v=3o7I0FxFNeQ
Oct 16, 2019 **...** Before **Phelps** became the most decorated Olympian of all time, he set the record
for the single most **Gold medals** at any single Olympic Games ...

Michael Phelps - **Medals**, Wife & Life - Biography
https://www.biography.com/athlete/michael-phelps
Apr 15, 2019 **...** **Michael Phelps** has accumulated a total of 28 **medals** at the Olympic Summer
Games in Athens, Beijing, London and Rio — 23 **gold**, three ...

ALL **Michael Phelps'** Olympic **Medal** Races from Rio 2016 | Top ...
https://www.youtube.com/watch?v=ObSDD2vfGMA
May 17, 2019 **...** Enjoy this look back at ALL of **Michael Phelps' medal** races from the 2016 ... 4
gold, 2 silver Rio 2016 : 5 **gold**, 1 silver And me buy **gold** in shop.

Who comes closest to **Michael Phelps' medal** count?
https://www.olympicchannel.com/en/stories/features/detail/most-decorated-summer-olympians-all-time-phelps/
Nov 14, 2019 **...** Answer: **Phelps** has 28 Olympic **medals** (23 **gold**, three silver, two bronze) in
swimming from four Games (Athens 2004 through to Rio 2016).

How much are **Michael Phelps's gold medals** really worth? - The ...
https://www.washingtonpost.com/news/wonk/wp/2016/08/12/how-much-are-michael-phelpss-gold-medals-really-worth/
Aug 12, 2016 **...** The Rio **gold medals** weigh 500 grams, the heaviest **medal** ever awarded in a

Seyyed MohammadSaleh Hosseini (sxh175430) – User Interface

michael phelps medal gold   **Search**

Page Rank   Query Expansion   Clustering   Vector Space   Google   **Bing**

Total results: 1210000

Michael Phelps - Wikipedia
https://en.wikipedia.org/wiki/Michael_Phelps
Michael Fred Phelps II (born June 30, 1985) is an American former competitive swimmer and the most successful and most decorated Olympian of all time, with a total of 28 medals. Phelps also holds the all-time records for Olympic gold medals (23), Olympic gold medals in individual events (13), and Olympic medals in individual events (16). When he won eight gold medals at the 2008 Beijing Games ...

Full list of every Olympic medal Michael Phelps has won
https://www.usatoday.com/story/sports/olympics/rio-2016/2016/08/07/michael-phelps-medals/88361712/
The most decorated athlete in Olympic history, American swimmer Michael Phelps finished his career with 23 gold medals and 28 overall. Phelps was just 15 years old when he made his Olympic debut ...

Michael PHELPS - Olympic Swimming | United States of America
https://www.olympic.org/michael-phelps
USA's Michael Phelps wins his fourth consecutive gold in the men's 200m individual medley. PHELPS, Michael Swimming United States of America. Swimming - 4x100m Medley Relay Men. Michael Phelps of the United States competes in the Men's 4 x 100m Medley Relay Final on Day 8 of the Rio 2016 Olympic Games at the Olympic Aquatics Stadium on August ...

Michael Phelps us - All EIGHT Gold Medal Races at Beijing ...
https://www.youtube.com/watch?v=3o7I0FxFNeQ
Before Phelps became the most decorated Olympian of all time, he set the record for the single most Gold medals at any single Olympic Games, the USA swimmer finished with 8 Gold medals at the ...

Michael Phelps Cover Shoot Behind The Scenes | Sports ...
https://www.youtube.com/watch?v=cgBCS00au14
Michael Phelps is back on Sports Illustrated's cover, but this time with his 23 Olympic gold medals. Subscribe to http://po.st/SubscribeSI Follow the late...

Michael Phelps | American swimmer | Britannica
https://www.britannica.com/biography/Michael-Phelps
Michael Phelps, American swimmer, who was the most-decorated athlete in Olympic history with 28 medals, which included a record 23 gold. At the 2008 Games in Beijing, he became the first athlete to win eight gold medals at a single Olympics. Phelps was raised in a family of swimmers and joined the

Michael Phelps - Medals, Wife & Life - Biography
https://www.biography.com/athlete/michael-phelps
Michael Fred Phelps (born June 30, 1985) is a retired American swimmer who holds the record for the most Olympics medals won by any athlete at 28.

Lionel Messi | Search

Page Rank | Query Expansion | Clustering | Vector Space | Google | Bing

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog-the-toe-poke/story/4088676/lionel-messi-and-cristiano-ronaldos-most-memorable-clashes-from-the-champions-league-to-el-clasico
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog/the-toe-poke/65/index
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Messi x Cristiano Ronaldo: astros se enfrentaram pela primeira vez há 12 anos
https://www.espn.com.br/futebol/artigo/_/id/6877422/messi-cristiano-ronaldo-astros-enfrentaram-primeira-vez-ha-12-anos-veja-numeros
Messi x Cristiano Ronaldo astros se enfrentaram pela primeira vez h anos Ir para o Menu Principal Menu ESPN scores Voc est na Edi o Brasil Para acessar edi es de outras regi es clique a

Laureus World Sports Awards: Simone Biles, Lewis Hamilton and Lionel Messi win - BBC Sport
https://www.bbc.com/sport/51539591
Laureus World Sports Awards Simone Biles Lewis Hamilton and Lionel Messi win BBC Sport Homepage Accessibility links Skip to content Accessibility Help BBC Account Notifications Home News Sport Wea

Lionel Messi | Search

Page Rank | **Query Expansion** | Clustering | Vector Space | Google | Bing

Assocation | Metric | Scalar | Pseudo Relevance

Expanded query: Lionel Messi ronaldo cristiano barcelona

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog-the-toe-poke/story/4088676/lionel-messi-and-cristiano-ronaldos-most-memorable-clashes-from-the-champions-league-to-el-clasico
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Messi x Cristiano Ronaldo astros se enfrentaram pela primeira vez h anos Ir para o Menu Principal Menu ESPN scores Voc est na Edi o Brasil Para acessar edi es de outras regi es clique a

Laureus World Sports Awards: Simone Biles, Lewis Hamilton and Lionel Messi win - BBC Sport

Lionel Messi   Search

Page Rank   Query Expansion   **Clustering**   Vector Space   Google   Bing

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog-the-toe-poke/story/4088676/lionel-messi-and-cristiano-ronaldos-most-memorable-clashes-from-the-champions-league-to-el-clasico
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Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog/the-toe-poke/65/index
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Laureus World Sports Awards: Simone Biles, Lewis Hamilton and Lionel Messi win - BBC Sport
https://www.bbc.com/sport/51539591
Laureus World Sports Awards Simone Biles Lewis Hamilton and Lionel Messi win BBC Sport Homepage Accessibility links Skip to content Accessibility Help BBC Account Notifications Home News Sport Wea

The Best FIFA Football Awards™ - FIFA.com
https://www.fifa.com/the-best-fifa-football-awards/
The Best FIFA Football Awards FIFA com EN News Photos Videos Visual Stories FIFA World Cup FIFA Women s World Cup Tournaments Ticketing FIFA Ranking Who

localhost:8888/olympics_search_engine/index.php?query=Lionel+Messi#clustering

Lionel Messi   Search

Page Rank   Query Expansion   Clustering   **Vector Space**   Google   Bing

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog-the-toe-poke/story/4088676/lionel-messi-and-cristiano-ronaldos-most-memorable-clashes-from-the-champions-league-to-el-clasico
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog/the-toe-poke/65/index
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Messi x Cristiano Ronaldo: astros se enfrentaram pela primeira vez há 12 anos
https://www.espn.com.br/futebol/artigo/_/id/6877422/messi-cristiano-ronaldo-astros-enfrentaram-primeira-vez-ha-12-anos-veja-numeros
Messi x Cristiano Ronaldo astros se enfrentaram pela primeira vez h anos Ir para o Menu Principal Menu ESPN scores Voc est na Edi o Brasil Para acessar edi es de outras regi es clique a

Laureus World Sports Awards: Simone Biles, Lewis Hamilton and Lionel Messi win - BBC Sport
https://www.bbc.com/sport/51539591
Laureus World Sports Awards Simone Biles Lewis Hamilton and Lionel Messi win BBC Sport Homepage Accessibility links Skip to content Accessibility Sport Wea

localhost:8888/olympics_search_engine/index.php?query=Lionel+Messi#vectorSp...

Lionel Messi   Search
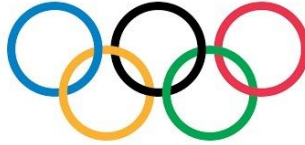
Page Rank   Query Expansion   Clustering   Vector Space   Google   Bing

Total results: 69500000
Search Time: 0.48 seconds

Mo Salah's incredible Liverpool record means he is catching **Lionel** ...
https://www.liverpool.com/liverpool-fc-news/features/mohamed-salah-liverpool-messi-ronaldo-18074295
Apr 10, 2020 ... What Mohamed Salah is producing as a goal-scorer is closer to what **Lionel**
Messi and Cristiano Ronaldo produced in their pomp for Barcelona ...

Lionel Messi chooses between Neymar and Lautaro Martinez
https://everythingbarca.com/2020/04/25/lionel-messi-chooses-neymar-lautaro-martinez/
1 day ago ... Barcelona cannot sign both of their chief targets going into the summer and
hence, they've consulted **Lionel Messi** for a recommendation.

Lionel Messi
https://www.worldfootball.net/player_summary/lionel-messi/
Lionel Andrés **Messi** Cuccitini - FC Barcelona, FC Barcelona B.

Lionel Messi leaving Barcelona 'no drama' for La Liga: Javier Tebas ...
https://www.insider.com/lionel-messi-leaving-barcelona-no-drama-la-liga-javier-tebas-2020-4
Apr 9, 2020 ... **Lionel Messi's** much-rumored departure from Barcelona would be 'no drama' for
Spanish football, and wouldn't hurt La Liga financially, the ...
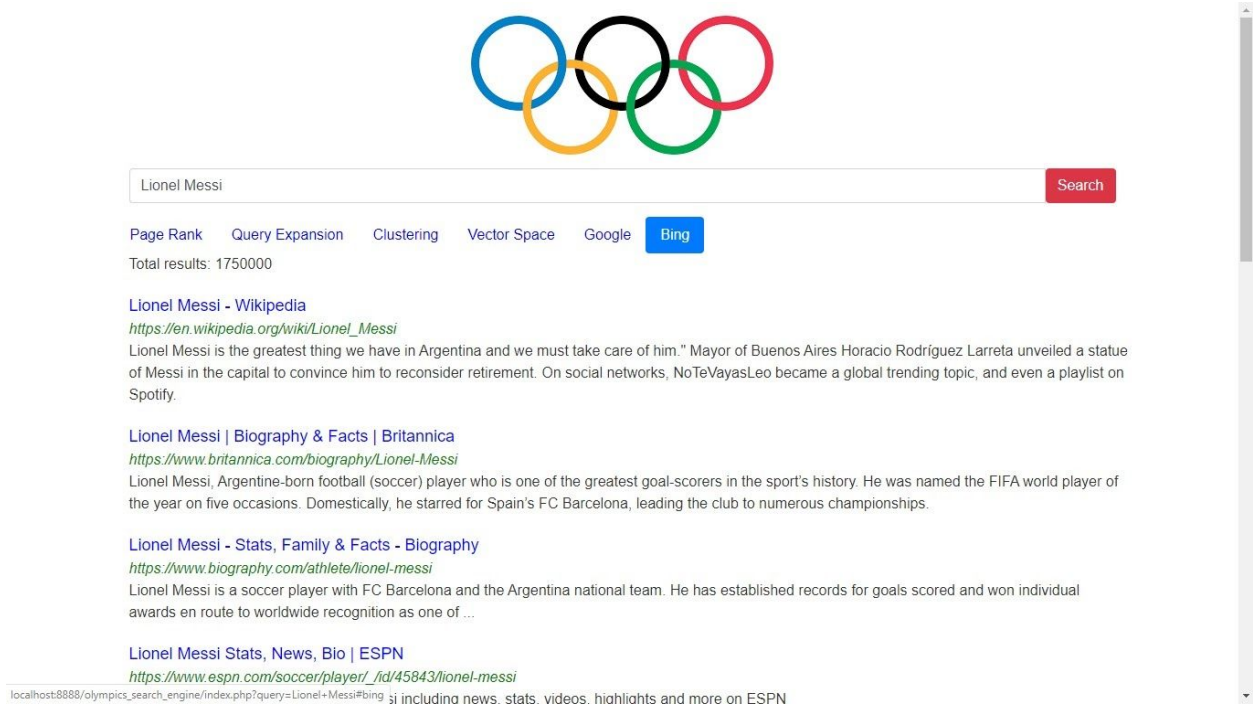
Wasif Haque (wah180000) - Clustering

5. Clustering (45 points):
Name: Wasif Haque, NetID: wah180000

Pre-processing

Before performing clustering, the content of the indexed documents needed to be cleaned and vectorized. From the index file (From Shrey Shah), I loaded all the document contents and ran them through some text processing such as removing punctuations, stopwords, expanding contractions, removing digits but keeping years etc. for all the 39232 documents that were indexed.

After that TfIdfVectorizer from scikit-learn was used to convert the processed documents to a 1000 dimensional vector space. Tf-idf vectorization took into account top 1000 terms in order to prevent the vector size from being too large while capturing the most important terms for vectorization.

Clustering

Once the vectors were prepared, I used K-Means and Agglomerative clustering on those vectors to group related documents together using the scikit-learn library.

K-Means clustering

Given a set of d documents where each document is represented by an n dimensional vector in some vector space k-means clustering partitions the documents in k sets (or clusters) by minimizing the within-cluster sum of squares. Here is a list of steps that are carried out:

- First an initial set of k means are initialized.
- Assign each document to the cluster with the nearest (by least squared euclidean distance) mean
- Recalculate means (or centroids) for the observations assigned to each cluster.
- Repeat until convergence.

Agglomerative clustering

Agglomerative clustering is a type of hierarchical clustering technique approach: each observation starts in its own cluster, and pairs of clusters are merged as one moves up the hierarchy. So, for each documents are initially assigned to their own clusters and then they are continually merged to hierarchically generate new clusters based on the distances (in this implementation, ward distance is used - ward minimizes the variance of the clusters being merged) between them. I used the scikit-learn library to implement agglomerative clustering

Wasif Haque (wah180000) - Clustering

Effect on Relevance

Given a search query search results are fetched from solr and ranked using PageRank. The top 100 results from PageRank were then compared with the clusters to reshuffle the ranking of the page which improved relevance of the search results. Here are examples of some query results -

Michael Phelps
[Search]

Page Rank   Query Expansion   Clustering   Vector Space   Google   Bing

Michael Phelps (@MichaelPhelps) | Twitter
https://twitter.com/MichaelPhelps
Michael Phelps MichaelPhelps Twitter We ve detected that JavaScript is disabled in your browser Would you like to proceed to legacy Twitter Yes Skip to content Home Home Home current page Mom

Michael Phelps on Twitter: "Some dreams/goals you just can't get rid of...been doing a lot of thinki
https://twitter.com/MichaelPhelps/status/848146735612526592
Michael Phelps on Twitter Some dreams goals you just can t get rid of been doing a lot of thinking n I ve decided that I m going make another comeback tokyo We ve detected that JavaScript

Michael Phelps
https://www.specialolympics.org/about/ambassadors/michael-phelps
Michael Phelps Facebook Google Plus Instagram Mail To LinkedIn Pinterest Pinterest Tumblr Twitter Youtube magnify greater than Quote Download Close Facebook Google Plus Mail To LinkedIn Twitter Our Wo

Michael PHELPS - Olympic Swimming | United States of America
https://www.olympic.org/michael-phelps
Michael PHELPS Olympic Swimming United States of America Javascript must be enabled for the correct page display skip to content Menu Olympic Games Olympic Games Olympic Winter Games Youth Olympic

Lionel Messi
[Search]

Page Rank   Query Expansion   Clustering   Vector Space   Google   Bing

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog-the-toe-poke/story/4088676/lionel-messi-and-cristiano-ronaldos-most-memorable-clashes-from-the-champions-league-to-el-clasico
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Lionel Messi and Cristiano Ronaldo's most memorable clashes From the Champions League to El Clasico
https://www.espn.com/soccer/blog/the-toe-poke/65/index
Lionel Messi and Cristiano Ronaldo s most memorable clashes From the Champions League to El Clasico Skip to navigation Menu ESPN scores NFL NBA MLB Soccer NCAAF MMA NCAAM Boxing CFL Chalk NCAA C

Laureus World Sports Awards: Simone Biles, Lewis Hamilton and Lionel Messi win - BBC Sport
https://www.bbc.com/sport/51539591
Laureus World Sports Awards Simone Biles Lewis Hamilton and Lionel Messi win BBC Sport Homepage Accessibility links Skip to content Accessibility Help BBC Account Notifications Home News Sport Wea

The Best FIFA Football Awards™ - FIFA.com
https://www.fifa.com/the-best-fifa-football-awards/
The Best FIFA Football Awards FIFA com EN News Photos Videos Visual Stories FIFA World Cup FIFA Women s World Cup Tournaments Ticketing FIFA Ranking Who

Usain Bolt   [Search]

Page Rank   Query Expansion   **Clustering**   Vector Space   Google   Bing

"My sports life is over" - Usain Bolt confirms retirement from all sport
https://www.olympicchannel.com/en/stories/news/detail/my-sports-life-is-over-usain-bolt-confirms-retirement-from-all-sport/
My sports life is over Usain Bolt confirms retirement from all sport My sports life is over Usain Bolt confirms retirement from all sport Skip to main content We ve partnered with selected med

When Usain Bolt lit up the track
https://www.olympicchannel.com/en/stories/features/detail/five-times-usain-bolt-reigned-supreme-track/
When Usain Bolt lit up the track When Usain Bolt lit up the track Skip to main content We ve partnered with selected media partners in the US to bring you Olympic Channel Plus content In order to vie

Back to Beijing: Usain Bolt's world record with an untied shoelace | OlympicChannel.com
https://www.olympicchannel.com/en/stories/news/detail/back-to-beijing-usain-bolt-s-100m-world-record-with-an-untied-shoelace/
Back to Beijing Usain Bolt s world record with an untied shoelace OlympicChannel com Back to Beijing Usain Bolt s world record with an untied shoelace OlympicChannel com Skip to main content We

Usain Bolt Biography, Olympic Medals, Records and Age
https://www.olympicchannel.com/en/athletes/detail/usain-bolt/
Usain Bolt Biography Olympic Medals Records and Age Events News Originals TV Sports Athletes Register Login Search EN Portugu s Fran ais Espa ol Deutsch Italiano Eng

I tested around 20 queries to check the relevance output. The queries were chosen based on different olympic venues, olympic participants and winners. The results were judged by manual inspection.

6. Query expansion and relevance feedback (45 points):

Written by the student that worked on this module. Describe how you have selected 20 queries to test the Rocchio algorithm of your search engine - list them in your reports (3 points). Give examples of the web pages that you found relevant and those that you found irrelevant – and explain your judgements (3 points). Show also the modified queries that resulted by applying Rocchio to your original queries (3 points). Discuss the 50 queries that you have used for pseudo-relevance feedback (3 points). For each of the three methods, i.e. associative clustering, metric clustering and scalar clustering show (1) examples of 3 queries, the local document set (2 points x 3); (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3); (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and (4) show the resulting expanded queries (2 points x 3). Also show the results of the search engine on your expanded queries and discuss them (3 points). Elaborate on how you have collaborated with the student responsible for the user interface to expose the results of your expanded queries as well (3 points). Discuss which queries and their expansion you selected for the demonstration of the project (3 points). Make sure that the name of the student responsible for this module appears prominently, along with the student netID on every page of the description of the query expansion usage in your team's search engine (5 points will be deducted if name/netID are missing).

Response

Various local and global methods can be used to improve the search results. Following are some of the local methods that can be used for query expansion:
1. Relevance Feedback (Rocchio Algorithm)
2. Pseudo Relevance Feedback:
   ○ Association cluster
   ○ Metric cluster
   ○ Scalar cluster

The following formula is used to implement the Rocchio Algorithm:

$$\vec{q}_m = \alpha\vec{q}_0 + \beta\frac{1}{|D_r|}\sum_{\vec{d}_j \in D_r}\vec{d}_j - \gamma\frac{1}{|D_{nr}|}\sum_{\vec{d}_j \in D_{nr}}\vec{d}_j$$

20 queries were fed as q_0 as inputs. The algorithm was tested by setting certain values for the parameters (alpha=1.0, beta=0.9, gamma=0.1).

Pseudo Relevance Feedback:

1. Association cluster: The stems which co-occur frequently inside documents have a synonymy association
2. Metric cluster: The stems which occur far apart in the document are less correlated to the terms that occur closer like in the same sentence.
3. Scalar cluster: The idea is that the two stems are more correlated if they have similar neighbourhoods.

20 queries chosen for testing Rocchio's algorithm:

1. 5 queries that have one keyword:
    a. Gymnastics
    b. Medals
    c. Gold
    d. Rio
    e. Michael

2. 5 queries that are based on players:
    a. Lionel Messi
    b. Michael Phelps
    c. Usain Bolt
    d. Serena Williams
    e. Dara Torres

3. 5 queries that were based on sports
    a. Swimming
    b. Soccer 2016
    c. Tennis rio
    d. marathon
    e. London archery

4. 5 queries based on medalists
    a. Boxing medalists
    b. Top swimmers
    c. Marathon winner
    d. Tennis runner up
    e. Soccer champion

Query	Relevant Web Pages
tennis rio 2016	https://en.wikipedia.org/wiki/Venues_of_the_2016_Summer_Olympics_and_Paralympics
	https://en.wikipedia.org/wiki/Puerto_Rico_at_the_2016_Summer_Olympics
	https://www.olympic.org/fr/rio-2016
gymnastics 2012	"https://www.olympic.org/gymnastics-artistic"
	https://www.olympicchannel.com/en/athletes/detail/carmelo-anthony/
	https://www.olympic.org/gymnastics-rhythmic
Medals	https://en.wikipedia.org/wiki/Olympic_medal_table
	https://tokyo2020.org/en/games/olympics-medals/

Query	Non Relevant Web Pages
tennis rio 2016	https://mobile.abc.net.au/news/rio-olympics-2016/sports/
Medals	https://en.wikipedia.org/wiki/Pierre_de_Coubertin_medal
	https://africa.espn.com/olympics/winter/2018/sports
	https://www.bbc.com/sport/olympics/37132833
gymnastics 2012	https://en.wikipedia.org/wiki/File:Synchronized_swimming_pictogram.svg
	https://en.wikipedia.org/wiki/File:Synchronized_swimming_pictogram.svg

We judge the first table results as relevant because the links answer the query that the user may have. When the user searches for medals, they would like to see the table showing who has won how many medals.

The results in the next table are marked is irrelevant because they do not reliably answer the questions of the user. When the query is related to gymnastics, the result of synchronized swimming pictogram is most probably not the best possible match that can be given.

Query	Modified Query
Gymnastics	Gymnastics beams
Medals	Medals olympics
gold	Gold bronze
rio	Rio olympic 2012
michael	Michael phelps medal
Lionel Messi	Lionel Messi Ronaldo Cristiano Barcelona

Michael Phelps	Michael phelps medal gold medals
Usain Bolt	Usain bolt olympic
Serena Williams	Serena williams time tennis
Dara torres	Dara torres medals twelve
swimming	Swimming summer 2020 history
Soccer 2016	Soccer 2016 rio football
Tennis rio	Tennis rio 2016
marathon	Marathon trials
London archery	London archery fit club
Boxing medalists	Boxing medalists
Top swimmers	Top swimmers time list all
Marathon winner	Marathon winner men athletics winners
Tennis runner up	Tennis runner up federer race
Soccer champion	Soccer champion football summer

For each of the three methods, i.e. associative clustering, metric clustering and scalar clustering, examples of 3 queries and their details are as follows:

Associative clustering:

    Query 1: gymnastics 2012

- **The local document set (document ids)**:
07dffaef52517b66da48d40d9a11f803
d7bd9c2da93720463f8893b070ee3d95
8737778eefe1bf20aa81f5f2e965c92d
63a339e9b949fcd1ba25a876688fa111
5cf520d4ae3d40cfb1f76fd9eec2ccac
b5a8746682dd852aa178bfdaec717713
355a0bc95bedba42e5c341575faabdf9
e15deb66fc7c97488b3185e416fb31bd
4e88ac89245a021b5e1e8647508f8142
86ce25e742e750d71b8fdc5d7971b3f3
e1b6412ad25fae753269c8767af566ad
962b1e5983db8d9ebe183cc345c99241
3c5a3b9ef5d7d0c47d5262276be01c85
3caa46092a31ac95c559ea43c21af859
1737220f7dd3346fb10b8a85783e5445
3353ccb2e6ac56209b45efbae3f78e86
09988da861e138ed0097178abc6b744d
5cb37f9944c29191041cd71defea4068
17530e95393b34fa7335b1cfe19b851d
2a917db4b9f7fe8d7790773a8567100f

(2) the local vocabulary and set of local stems as well as their vocabularies :

Stem set: { ab, abbrevi, abil, abl, ablat, ablatedlength, ablationr, ablev, about, about053, abov, abovement, abrupt, abruptli, abruptstal, absenc, absent, absolut, absorb, absorpt, abstract, abundantli, academ, acceler, accelerationtoler, acceleromet, accentu, accept, access, accident, accommod, accompani, accomplish, accord, accordingli, account, accru, accumul, accur, accuraci, acet, achiev, ackeret, acoust, acquir, acquisit, acr, acrodynam, across, acrothermochemistri, acrothermoelast, act, action, activ, actual, actur, ad, adam, adapt, add, addendum, addit, adequ, adequaci, adiabat, adiabaticwal, adjac, adjacentequilibriumposit, adjoin, adjoint, adjust, administr, admiss, admit, admixtur, adopt, adsorpt, advanc, advancediamet, advantag, advent, advers, advisori, advoc, aec, aeolotrop, aerfoil, aerialground, aero, aero2441, aeroballist, aerocosmonaut, aerodynam, aerodynamiccent, aerodynamiccentr, aerodynamicthermoelast, aerodynamieist, aeroelast, aerofoil, aeronaut, aeroplan, aerotherm, aerothermochem, aerothermodynam, aerothermoelast, affect, affin, affirm, afford, aforement, afresh, aft, after, afterbodi, afterbodyjetnozzl, afterburn, afterflow, ag, again, against, agenc, ago, agre, agreement, ahead, aid, ailcron, aileron, ailerontab, aim, air, airborn, aircraft, aircraftenginepropel, aircrafttyp, aircushion, airdens, airflow, airfoil, airforc, airfram, airinduct, airit, airjet, airlin, airload, airplan, airreceiv, airscrew, airspe, airstream, akin, al, alfven, algebra, align, allen, allevi, allmov, allmovablecontroltyp, alloi, allow, alloys75st6, allround, allud, almen, almost, alon, along, alreadi, also, alter, altern, although, altitud, altogeth, aluminium, aluminum, aluminumalloi, alwai, am, ambient, ambigu, amen, america, american, ammonium, among, amongst, amount, ampl, ampli, amplif, amplifi, amplitud, amr, analog, analogu, analys, analyseseg, analysi, analyt, analytici, analyz, and058, and2how, andabrespect, andor, anemomet, angl, angleofattack, angular, angularli, anh, anhedr, anid, anisotrop, anisotropi, annex, announc, annual, annul, annular, annulardisk, annulu, anomal, anomali, anoth, anovement, answer, antielast, antisymmetr, anywai, aob, apart, apex, apexangl, apoge, appar, apparatu, apparentmass, appear, append, appendic, appendix, appl, appli, applic, apprais, appraoch, appreci, approach, appropri, approx, approxim, approximationi, apropri, ar, ara, arbitrari, arbitrarili, arc, arcdischarg, archeat, ardc, area, areamach, areamean, argon, argonfre, argu, argument, aris, arisen, arithmet, arm, armenaka, around, arrang, arrest, arrheniu, arriv, arrow, art, articl, artific, artifici, arylay, ascend, ascertain, ascrib, asid, asimplifi, ask, asm, aspect, aspectratio2, aspectratio6, asreceiv, assembl, assert, assess, assign, assist, associ, assort, assum, assumpt, assur, astronaut, astrophys, asymmetr, asymmetri, asymptot, at, atlarg, atm, atmospher, atmospherei, atmosphererath, atom, atommolecul, attach, attachedflow, attack, attain, attaindd, attempt, atten, attend, attent, attenu, attitud, attract, attribut, augment, august, aural, auspic, author, autocorrel, automat, auxiliari, avail, avalu, avenu, averag, avoid, avov, avro, awai, ax, axi, axial, axialflow, axialforc, axiallysymmetr, axialthrust, axisymmetr, azimuth, b, back, background, backup, backwardfac, baglei, bai, bakanov, balanc,

ballist, ballistictyp, balsa, ban, band, bandpass, bandwidth, bang, bank, bar, bare, barrel, barrier, base, baseforward, basepressur, basetojet, basetyp, basi, basic, basicflow, basin, batchelor, batdorf, bc, be, beam, bean, bear, beat, becam, becaus, becausewith, becom, bed, bedford, befor, beg, began, begin, begun, behav, behavior, behaviorccontrolsystem, behaviour, behind, belief, believ, bell, bellevil, belltyp, belong, belotserkovskii, below, belt, bend, bendingmo, bendingtors, bendingtotors, beneath, benefici, benefit, bent, ber, bergdolt, berger, bernoullieul, berthelot, bertram, beskin, bessel, best, bestfit, better, between, bevel, beyond, beyween, bibliographi, biconvex, bifurc, biharmon, billow, bimetal, bimolecular, bimolecularexchang, binari, binarymixtur, biot, birnbaum, bisector, blade, bladesurfac, bladetoblad, blasiu, blasiuss, blast, blastproduc, blastwav, bleed, bleich, blend, block, blockag, blow, blowdown, blowdowntyp, blown, blowout, blue, bluff, bluffafterbodi, bluish, blunt, bluntbas, bluntbodi, blunter, bluntnos, blunttrailingedg, board, boattail, bodi, bodyaxi, bodydiametermaximumspan, bodyforc, bodyvolum, bodyw, bogdonoff, boiloff, bolshakov, boltzmann, bomb, bomber, bond, bondpackard, bondstress, bonu, book, boom, boomproduc, boost, booster, bore, born, bornel, both, bottom, bound, boundari, boundarycondit, boundarylay, boundarylayercontrol, boundarylayerinduc, boundarylayershockwav, boundarylayertyp, boundaryvalu, boundwel, bourn, bow, bowshock, box, boxw, bracket, brake, branch, branchlin, brass, braunschweig, breadth, break, breakdown, breath, breguet, bridg, brief, briefli, bright, bring, british, broad, broaden, broadspectrum, broke, broken, brooklyn, brought, brown, btu, btulb, bubbl, buckl, buckledpanel, budianski, buffet, build, built, builtup, bulent, bulg, bulk, bulkhead, bullet, buoyanc, buoyant, bureau, burger, burgerss, buri, buriedfan, burn, burst, busemann, butler, buzz, bycharacterist, bypass, c, c035, cabin, cal, calcualt, calcul, calculatebi, calculu, calculusofvari, calib, calibr, california, call, calor, camber, cambridg, camera, can, canard, cancel, cannot, cant, cantilev, cap, capabl, capac, capacit, capillari, caplan, capsul, caravel, carbon, carborundum, care, carefulli, caret, carri, carrier, carter, cartesian, cascad, case, caseson, cast, castigliano, castolit, catalyt, categori, cater, cathoderai, cauchi, caus, cavit, caviti, ceas, cell, cellular, cellulos, cent, centaur, center, centerbut, centerlin, centerofgrav, centerofpressur, centigrad, centr, central, centrebodi, centrelin, centresect, centrifug, centripet, centroid, certain, certainli, certainti, ceuler, cf, cg, chain, chamber, chang, channel, chap, chapman, chapmanenskog, chapmanjouguet, chapmanrubesin, chapter, charact, character, characterist, characteristi, charg, chargedparticledens, chart, charter, chartsfigs16it, chase, check, chemic, chemisorpt, chemistri, cheng, chernyi, cheski, chester, chief, chiefli, chien, child, chinaclai, chlorid, choic, choke, choleski, choos, chord, chordwis,

chosen, chu, circl, circuit, circuitri, circul, circular, circulararc, circularblad, circularcon, circularcylindr, circulatori, circumfer, circumferenti, circumlunar, circumscrib, circumst, cite, civil, ck, claim, clamp, clampededg, clamshellshap, clarifi, class, classic, classif, classifi, classificaiton, claus, clear, clearanc, clearli, climb, climin, close, closedcontour, closedform, closedjet, closer, closest, closur, cloud, cm, co, co2, coalesc, coars, coast, coat, coauthor, coaxial, cocurr, code, coeffici, coefstant, coher, coincid, cold, coldair, coldbodi, colder, coldwal, cole, collabor, collaps, collapsesin, collect, collis, collisionfre, colloc, colour, column, columncapac, columnimperfect, columnmateri, combin, combust, combustionh, combut, come, command, commenc, comment, commerci, committe, common, commonli, commun, compact, compani, companion, compar, comparison, compat, compens, compet, competit, compil, complement, complementari, complet, completecompressorstal, complex, complic, complimentari, compon, compos, composit, compound, comprehens, compress, compressedair, compressibleboundarylay, compressibleflow, compressiblefluid, compressiblelaminarboundarylay, compression, compressioncorn, compressor, compressorsdash, compris, compromis, comput, computingmachin, concav, conceiv, concentr, concept, conceptu, concern, concis, conclud, conclus, concoct, concret, concur, concurr, condamp, condens, condit, conduct, conductioncontrol, conductionexpans, conductor, cone, conecylind, conecylinderflar, conecylinderfrustum, conecylinderfrustumboost, conefrustum, conehemispher, coneseg, conespher, confid, configur, confin, confirm, conflict, confluent, conform, conformaltransform, confus, congress, conic, conicaldash, conicalflow, conicalshockexpans, conidt, conjectur, conjunct, connect, connexion, consequ, conserv, conservationofmomentum, consid, consider, considereddashthat, consideredid, consier, consist, consolid, const, constanc, constant, constantarea, constantchord, constantdens, constantenergi, constanth, constantli, constantpressur, constantproperti, constantsthei, constantstrength, constantstress, constanttemperatur, constantwalltemperatur, constitu, constitut, constrain, constraint, construct, consumpt, contact, contain, contamin, contempl, content, context, continu, continuum, continuumflow, continuumtyp, contour, contract, contradict, contrari, contrast, contribut, contributionsviz, control, controlsurfac, controversi, convect, convectioni, conveni, convent, converg, convergentdiverg, convergingdiverg, convers, convert, convex, convict, convolut, cool, coolant, cooler, cooper, coordin, coordinatetyp, cope, coplanar, copper, core, cornel, corner, corollari, corot, corpor, corpuscular, correct, correctli, correl, correlogram, correspond, correspondingli, corridor, corrobor, corrug, corrugatedcor, cosin, cosmonaut, cost,

couett, couettetyp, could, coulomb, council, count, counter, counteract, counterclockwis, counterpart, counterrot, countri, coupl, coupledmod, coupon, cours, cover, coverag, cowl, cowlingspinn, cowork, cp, crabtre, crack, craft, cranknicolson, creas, creat, creep, creepbend, creepbuckl, creepingmot, creepruptur, crest, crew, crinolin, criteria, criterion, critic, crocco, croccole, crook, crop, croppeddelta, cross, crosscorrel, crosscoupl, crossdrift, crossflow, crossflowplan, crosssect, crucial, cruciform, cruciformw, cruis, crush, cubic, cumbersom, cumul, cure, curlingup, current, curtain, curv, curvatur, curvedbeam, curvedsurfac, curvilinear, cushion, cusp, cuss, customari, cut, cutoff, cutout, cx, cycl, cyclessec, cyclic, cylind, cylinderhemispher, cylindr, cylindricalbodi, d, d48, d693, dai, dalei, damag, damp, dampinginpitch, dampinginyaw, dampomet, dana, dand, danger, dash, dashn, data, date, davi, daytim, daytonight, db, dc, de, dead, deadair, deadweight, deal, dealt, debat, deby, decad, decai, deceler, decelerationlimit, decid, decidedli, decim, decis, declassifi, declin, decompos, decomposit, decreas, decrement, deduc, deduct, deep, deeper, deepest, deexcit, defect, defenc, deffer, defi, defici, deficit, defin, definit, deflagr, deflect, deflectedslipstream, deflectiontim, deflexion, deform, deg, degener, degrad, degre, degreehalfangl, deioniz, deisgn, delai, delft, delimit, delin, delta, deltaw, demand, demarc, demonstr, denc, denomin, denot, dens, denser, densiti, densitycan, densityviscos, dent, depart, departur, depend, depict, deplet, deposit, depress, depth, deriv, deryagin, descend, descent, describ, descript, design, designtyp, desir, desk, despit, destabil, destal, detach, detail, detailth, detect, deterior, determin, determinant, deton, detra, detriment, deuc, develop, developmentit, deviat, devic, devis, devot, devreas, dewpoint, diagon, diagram, diam, diamet, diameterthick, diamond, diamondprofil, diamondshap, diaphragm, diatom, dicsov, dictat, did, dielectr, differ, differenti, difficult, difficulti, diffus, digit, digitalcomput, dihedr, dilat, dilut, dimens, dimension, dimensionless, diminish, dioxid, dipol, dirac, direct, directli, directorgener, dirichlet, dirt, disadvantag, disagr, disagre, disappear, disc, discern, discharg, disclos, discontinu, discontinuouswak, discov, discoveri, discrep, discret, discretefrequ, discretehorseshoevortex, discretetyp, discuss, disequilibrium, disk, disloc, dismiss, dispar, dispers, displac, displacementarea, displai, dispos, disregard, dissert, dissimilar, dissip, dissoci, dissociatingga, dissociationrecombin, distanc, distancetim, distant, distinct, distinctli, distinguish, distort, distribut, disturb, disturbancewhich, diurnal, dive, diverg, divers, diversifi, divid, divis, do, doctor, dodecagon, doe, domain, dome, domin, done, donnel, donnelltyp, doppler, dorodnitsyn, dorodnitzinhowarth, dorodnitzyn, doubl, doublesid, doubleslot, doublet, doublewedg, doubli, doubt, down, downstream,

downstreampropag, downward, downwash, drag, dragdiverg, dragmodul, dragris, dramat, drape, drastic, draw, drawn, drew, driest, drill, drive, driven, driver, droop, drop, dropoff, drosophila, drum, drumcamera, dry, dryden, dual, dualpropel, dualrot, duce, duct, dudx, due, dufour, duplic, duralumin, durat, dure, dust, dvl, dy, dyke, dynam, dynamicanalog, dynamicpressur, e, e02, e53h25, ea, eab, each, earli, earlier, earth, eas, easi, easier, easiest, easili, eccentr, echo, eckert, econom, economi, ed, eddi, eddyviscos, edelfelt, edg, edgedisplac, edgeload, edgesto, edgetract, edgewis, edit, edpm, educ, edward, effect, effectmai, effectorigin, efficaci, effici, efficiencywer, efflux, effort, effus, eg, egat, egger, eigenvalu, eigenvector, eight, eighth, eighthord, einbind, either, ejector, elabor, elaps, elast, elasticaxi, elasticbehavior, electr, electricallyh, electricanalog, electricresist, electrod, electroformednickel, electrohydrodynam, electromagnet, electron, electronion, electrostat, eleg, element, elementari, elev, elevatedtemperatur, elimin, elliott, ellips, ellipsecylind, ellipselik, ellipsoid, ellipt, elsewher, embed, embrac, embryon, emerg, emiss, emit, emmon, emphas, emphasi, emphasis, empir, empiricalintermedi, emploi, employ, enabl, enc, encircl, enclos, encompass, encount, encourag, end, endeavour, endors, endplat, endpoint, endshorten, endur, energi, energymethod, energyrequir, enforc, engag, engess, engin, enginemount, enginepropel, england, enhanc, eniac, enjoi, enlarg, enlighten, enorm, enough, enquiryto, ensu, ensur, entail, enter, enthalp, enthalpi, enthalpyus, enthalpyveloc, entir, entireti, entitl, entrain, entranc, entri, entropi, entropylay, envelop, environ, environment, envisag, epoxi, eq, equal, equalspan, equat, equatori, equicohes, equilateraltriangl, equilibr, equilibria, equilibrium, equip, equival, equivalentcon, eratur, erdmannweierstrass, erfc, erickson, erod, eros, errat, error, errorintegr, errorssdof, escap, especi, essenc, essenti, establish, estim, et, etal, etc, eter, ethylen, ethyleneh, eucken, euckenvalu, euler, eulerian, eulerlagrang, ev, evalu, evapor, even, event, eventu, everi, eversustim, everywher, evid, evidenc, evolv, evvard, exact, exactli, exagger, examin, exampl, exce, exceed, excel, except, exception, excess, exchang, excit, exclud, excresc, excus, exercis, exert, exhaust, exhaustpressur, exhibit, exist, exit, exitarea, exot, expand, expans, expansioncontrol, expansiondeflect, expansionturn, expansionwav, expect, expend, expenditur, expens, experi, experienc, experiment, experimentalfailur, explain, explan, explicit, explicitli, exploit, explor, exploratori, explos, expon, exponenti, exponentiallyfici, expos, exposit, exposur, expound, express, extend, extens, extensiblechord, extension, extent, exterior, extern, externalflow, externalskin, extinct, extra, extrapol, extrem, ey, f, f0, f100, f2layer, f40umer, f8u3, fa, fabric, face, facet, facil, facilit, fact, factor, factorspropuls, fage, fai, fail, failur, fair, fairli, fale, falkner,

falknerskan, fall, famili, familiar, fan, far, farfield, farflow, farther, fashion, fast, fasten, faster, fat, fatigu, favor, favour, fd, feasibl, featur, fed, feed, feedback, feel, feet, feldman, fell, felt, ferri, fewer, ff, fiber, fibrou, fictiti, field, fifth, fifthdegre, fifti, fiftyon, fig, fighter, fightertyp, figur, filament, fill, film, filter, fin, final, financi, find, fine, finenessratio, finenessratio271, finenessratiobeen, finest, finish, finit, finitediffer, finitedisplac, finitespan, finitethick, finstabil, fire, firingrang, firm, firmer, first, firstord, fissionth, fit, five, fivestag, fiveterm, fix, fixedgeometri, fixedpitch, fk, flame, flang, flap, flare, flarecylind, flash, flat, flatbas, flatfac, flathead, flatnos, flatpanel, flatplat, flattop, flex, flexibl, flexur, fli, flight, flightpath, flighttest, fllayer, float, floatingel, floccul, floor, floorpressur, flow, flowdash, flowfield, flowi, flowin, flowmet, flown, flownot, flowsthat, flowvisu, fluctuat, flugg, fluid, fluidcylind, fluiddynam, fluidflow, fluidiz, fluidpressur, fluidsolid, flutter, flutterar, fluttermod, flutternam, flutterprevent, flutterspe, flux, fly, fn, focu, focus, fog, foil, fold, follow, foot, forc, forceand, forcedeform, forcefre, forcetest, forcibl, fore, forebodi, forecast, foredrag, forefront, forego, foreign, foreknowledg, form, formal, format, former, formul, formula, fort, forth, fortythre, forum, forward, forwardacceler, forwardexhaust, forwardfac, forwardflight, forwardfuselag, forwardfuselagesect, found, foundat, four, fourcompon, fourengin, fourhol, fourier, fourpol, fourth, fourthdegre, fourthord, fourwav, fp, fpre, fr, fraction, fractur, fralich, frame, framework, franc, fredholm, free, freeconvect, freedom, freefield, freeflight, freeflown, freefre, freejet, freelysupport, freeman, freemix, freemolecul, freeshear, freestream, freestreaminject, freevortex, freez, freon, freon12, frequenc, frequencyband, frequencyshift, frequencyth, frequent, friction, frictionless, friedman, friedrich, fring, from, front, frontal, frozen, frozenflow, fruit, frustrat, frustum, ft, ftsec, fuel, fuelto, fulfil, full, fuller, fulli, fullscal, fullskirt, fullspan, fullyexpand, function, fundament, furnac, furnish, further, furthermor, fuse, fuselag, futur, fx, fz, g, ga, gage, gain, galcit, galerkin, gamma, gap, garabedian, gardless, garrick, gascou, gasdynam, gase, gaseou, gasmixtur, gather, gaug, gauss, gaussian, gaussseidel, gave, geckel, geiger, gener, generalis, generalizednewtonian, genuin, geodes, geoffrei, geometr, geometri, geophys, gerard, german, gershuni, get, gibbsdalton, gies, give, given, glass, glassi, glauert, glide, glider, gload, globul, glycerinwat, go, goal, goe, goldstein, good, goodier, gorcum, gordon, gortler, gothic, govern, grad, grade, gradient, gradual, graham, grain, gramsc, grand, granulartyp, graph, graphic, graphit, grashof, grasshof, gravalo, gravel, gravit, graviti, gravitywav, graze, great, greater, greatest, greatli, green, grid, gridnor, gridwork, grimming, grober, gross, grossman, grossweight, ground, groundeffect, groundheight, groundpressur, groundreflect, group, grow, growth, guarante, guid, guidanc, gun, gupta, gust, gw, gyrat, gyroscop, h, h2, h2o, ha, haag, had, hadamard, hai, half, halfangl, halfcon, halfheight, halfjet, halfmodel, halfrang,

halfspac, halfw, halfwai, hall, hallcurr, halstead, halv, hammerhead, hammitt, hamper, hand, handicap, handl, handlei, hankel, hansen, hantzsch, happen, hard, harden, hardli, hardwar, harmon, harri, hartmann, hartre, hartreewomerslei, hash, hasimoto, hasten, have, haveg, havelock, hay, hazard, head, heaslet, heat, heatabsorpt, heatbal, heatconduct, heater, heatflow, heatflux, heatingr, heatinput, heatinsul, heatsink, heattransf, heav, heavi, heavier, height, heighth, heightthick, heightto, heighttochord, heighttojet, heimel, heimenz, heisenberg, held, helic, helicopt, heliocentr, helium, heliumdriven, helmholtz, help, hemispher, hemisphereconecylind, hemispherecylind, hemisphericallynos, hemisphericalnos, hemispheroid, henc, hencki, herein, heretofor, hero, herrmann, heterogen, hexagon, hg, hicks2, hidalgo, high, highaltitud, highaspectratio, highbeta, highdrag, highenergi, highenthalpi, higher, higherord, highest, highfrequ, highg, highli, highlift, highlycool, highpow, highpressur, highpressureratio, highspe, highstagnationtemperatur, highsupersonicspe, hightemperatur, highveloc, himself, hinder, hing, hingeaxi, hingemo, hirschfeld, hirshfeld, hise, histor, histori, hit, hitherto, hk, hm, hodograph, hoff, hoffmantel, hog, hold, holder, hole, holland, hollow, hollowcylind, homann, home, homogen, honeycomb, hoop, hope, hopeless, hopelessli, hopf, horizont, horizontaltail, horsesho, hoshizaki, hosokawa, hot, hotbodi, hotfatigu, hotga, hotter, hotwir, hour, hous, housefli, hover, hovercraft, howarth, howev, howorth, hpdpdy, hpyerson, huang, hub, hubshroud, hugoniot, human, humid, humphrei, hundr, hurd, huv, hybrid, hydraul, hydroballist, hydrocarbon, hydrodynam, hydrogen, hydrogendriven, hydrogenoxygen, hydromagnet, hydrostat, hypass, hyperbol, hyperbolicsin, hyperbolictrigonometr, hypergeometr, hyperlipt, hyperson, hypersonicflow, hypersonicsimilar, hypersonicslenderbodi, hypersoul, hyperveloc, hypothes, hypothesi, hypothet, hysol, hysteresi, hysteret, ia, ibeam, ibm, ibm704, icbm, idea, ideal, idealga, ident, identif, identifi, ie, if, ifer, igc, igi, ignit, ignor, ii, iii, illustr, illustri, im, imag, imaginari, imai, immedi, immers, immobil, immov, impact, impactpressur, impair, impart, impel, impellertip, imperfect, imperfectga, imperm, imping, impingingjet, implement, impli, implic, implicit, import, impos, imposs, impress, imprimeri, improp, improv, impuls, inaccess, inaccur, inaccuraci, inadequ, inadequaci, inadmiss, inadvert, inapplic, inappropri, inasmuch, inboard, inch, incid, incident, incipi, incipientmergedlay, inclin, includ, inclus, incom, incomplet, incompress, incompressibleboundarylay, incompressibleflow, incompressiblefluid, inconclus, inconel, inconsist, inconveni, incorpor, incorrect, increas, increasingli, increment, incrementalnormalforc, incur, inde, indefinit, independ, indetermin, index, indic, indici, indirect, indirectli, indium, individu, induc, induceddrag, inducedpressur, induct, industri, ineffici, inelast, inequ, inert, inerti,

inertia, inevit, inexpens, infer, infin, infinit, infiniteaspectratio, infiniter, infinitesim, infinitythat, inflect, inflight, inflow, influenc, influencecoeffici, influenti, influx, inform, ing, ingeni, inher, inhibit, inhomogen, initi, inject, injectioncool, injector, inkflow, inlet, inletmassflowcoeffici, inletveloc, inner, innershock, innertub, inop, inorgan, inphas, inplan, input, inquir, insect, insensit, insert, insid, insight, insignific, insofar, inspect, inspir, inst, instabl, instal, instanc, instant, instantan, instead, instig, institut, instruct, instrument, insuffici, insul, insulatedpl, insulatedwal, insur, intak, integr, integraldifferenti, integralequ, integrand, integrodifferenti, intend, intens, intensif, intensifi, intent, intention, interact, interanl, interblad, interchang, interconnect, intercrystallin, interdepend, interest, interestit, interfac, interfer, interferogram, interferomet, interferometr, intergranular, interim, interior, intermedi, intermediatespe, intermolecular, intern, internat, interplanetari, interpol, interpos, interpret, interrel, intersect, intersectiontyp, interstellar, interv, intim, into, intract, intrins, introduc, introduct, introdur, intuit, invalid, invari, invers, invert, investig, investigationfor, inviscid, inviscidflow, inviscidflowfield, inviscidfluid, inviscidhypersonicflow, inviscidincompressibleflow, inviscidvisc, invok, involv, inward, iodin, ion, ioniz, ionospher, iowa, irbm, iron, irregular, irrespect, irrevers, irrot, isect, isentrop, isobar, isochronousstressstrain, isoenerget, isofoam, isol, isotherm, isotop, isotrop, isotropiccor, isovel, issu, itechn, item, iter, iterationi, itself, iv, ivi, j, jacobian, jan, janzenrayleigh, japan, jastrow, jchemphys262feb1957, jefferyhamel, jet, jetboundari, jeteffect, jetengin, jetengineexhaust, jetexit, jetflap, jetflow, jetinduc, jetinterfer, jetlik, jetnozzl, jetoff, jeton, jetplum, jetpressur, jetstaticpressur, jetstaticpressureratio, jetstream, jettobodi, jmin, jmjn, johnson, join, joint, jointli, jone, joukowski, joul, journal, judg, judici, juli, jump, junction, junctur, june, jupit, just, justif, justifi, k, k05, k1th, k20, kallmann, karman, karmanpohlhausen, katzen, kay, keep, kei, kellei, keller, kelli, kelvin, kemp, kempf, kempner, kendrick, kept, kernal, kernel, kernelfunct, keulegan1, keune1, kg, kilometr, kind, kinemat, kinet, kinetictheori, kink, kirchhoff, kirchhoffhelmholtz, kirchhofflov, kirk, klein, km, knee, know, knowledg, known, knuckl, knudsen, ko, kopal, kopalfor, korst, krasilshchikova, krypton, kt, kuchemann, kussner, kutta, kuttajoukowski, l, l57l10, l5d20, la, labor, laboratori, labori, labour, lack, lacquer, lag, lagrang, lagrangian, laguerr, laid, lamin, laminar, laminarboundari, laminarboundarylay, laminarboundarylayertyp, laminarflow, laminarturbul, laminarvisc, land, landahl, langer, langlei, languag, lap, laplac, laplacian, larg, largeamplitud, largeangl, largeaspectratio, largechord, largedeflect, largedeflexion, largediamet, largeeddi, largematrix, largeord, larger, largescal, largest, largestep, largeth, last, lastli, laszlo, late, latent, later, lateraldirect, latitud, latter, lattic, laufer, launch, laval, law, lawspe, layer, layerfre, layeri, layershock, layout, lb, lband, ld, lead, leadingedg, least, leav, lectur, led, lee, leeshroma,

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minut, mirel, mirror, misalign, misalin, mise, misess, mismatch, miss, missil, missiletyp, mission, mistak, mit, mitig, mitnaca, mix, mixedflow, mixinglay, mixinglength, mixtur, mm, modal, mode, modefrequ, model, moder, moderatelength, modern, modeshap, modest, modif, modifi, modifiedoseen, modifiedthicknessratio, modul, modulu, mol, molecul, molecular, molten, molybdenum, moment, momentand, momentari, momentum, momentumarea, momentumintegr, momentumthick, monatom, monocoqu, monograph, monoplan, monopol, monoton, monoxid, moon, moor, more, moreov, morn, most, mostli, motion, motionless, motionpictur, motor, mound, mount, mountain, move, movement, mph, ms, msvo, mth, much, muffler, muller, multiaxi, multibai, multicellular, multicompon, multidegreeoffreedom, multilay, multipl, multiplenozzl, multiplepass, multiplepropel, multiplevalu, multipli, multiplyconnect, multisect, multistag, multiweb, mum, munk, murphi, murrai, must, mutual, myself, n, n2, naca, nacel, nacelleexit, nacellepropel, nagamatsu, name, narrow, nasa, nash, nation, national, natur, nautic, naval, navi, navierstok, navysponsor, nb, nd, near, nearcon, nearer, nearest, nearfield, nearli, nearmaximum, nearson, nearspher, neartriangular, neater, necess, necessari, necessarili, necessit, need, neg, negat, neglect, neglectedan, neglig, neighborhood, neighbour, neighbourhood, neither, net, network, neumann, neutral, neutralparticl, never, nevertheless, new, newlycomput, newton, newtonbusemann, newtonian, newtonianpluscentrifug, newtoniantheori, next, ngte, nice, nickelbas, nielsen, night, nighttim, nimon, nine, ninefold, nineteen, ninth, nitric, nitrogen, nitrogenatom, no, no1, no2, no320, no500, nocturn, nodal, node, nogw533on, nois, noisefre, nomenclatur, nomin, nomograph, nonabl, nonalign, nonaxisymmetr, noncatalyt, noncircular, noncirculatori, noncommun, nonconcurr, nonconduct, nonconserv, noncorros, nondecompos, nondimension, nondissip, nonequilibrium, nonexist, nonflamm, nongyroscop, nonheatconduct, nonhomogen, noninclin, noninject, noninsul, nonirrit, nonisentrop, nonisotherm, nonlift, nonlinear, nonlinearpressur, nonmagnet, nonneg, nonorthogon, nonparallel, nonperm, nonplan, nonpor, nonreact, nonrigor, nonrot, nonrotation, nonsimilar, nonsingular, nonslationari, nonslend, nonspher, nonstationari, nonsteadi, nonsymmetr, nontox, nontrivi, nonuniform, nonvanish, nonvisc, nonzero, nor, normal, normalforc, normalforcecurv, normalforwardflight, normalpressur, normalshock, norman, noschmidt, nose, noseafterbodi, nosebluntnessinduc, nosecon, nosedown, noseforward, nosetail, noseup, noslip, not, notabl, notat, notch, note, notednam, noteworthi, notic, notion, notsoslend, novel, now, nozzl, nozzleafterbodi, nozzlearea, nozzleexit, nozzleexpans, nozzleflow, nozzleprovid, nozzlethroat, nozzlewal, np, npl, nth, nuclear, nullifi, number, numbersespeci, numer, numger, nusselt, nylon, o, o2, ob, obei, object, objection, oblat, obliqu, obliqueshock, obliter, obscureand, observ, obstacl,

obtain, obtainec, obviou, obvious, oc, occas, occasion, occupi, occur, occurr, occurspast, octagon, octahedralshear, octav, octob, off, offdesign, offer, offset, ofr, often, oftenus, oge, ogiv, ogivecylind, ohm, oil, oilfilm, oilflow, old, omiss, omit, on, onc, oncom, onedegreeoffreedom, onedimension, onefourth, onehalf, oneparamet, onequart, onera, onetenth, onethird, onli, onsag, onset, onsetofseparationeffect, onto, opaqu, open, openarea, openend, opennos, oper, opportun, oppos, opposit, optic, optim, optimizationddesign, optimum, optimumprogram, orbit, order, orderofmagnitud, ordin, ordinari, ordnanc, organ, orgin, orient, orific, origin, origint, orlfic, orrsommerfeld, orthogon, orthotrop, oscil, oscillatori, oscillograph, oseen, oseentyp, osoen, ostrach, oswatitsch, other, otherwis, our, out, outboard, outcom, outer, outeredg, outermost, outgrowth, outlet, outlin, outofstraight, output, outsid, outstand, outward, outweight, oval, ovalshel, ovalu, oven, over, overal, overcom, overestim, overexpand, overexpans, overhang, overlap, overli, overlook, overpressur, overrelax, overrid, overshadow, overshoot, oversimplif, oversimplifi, overst, overstat, oversw, ow, owen, own, oxid, oxygen, oxygenlik, p, p2859015h20046500280013h20046, p43, page, pai, paid, painlev, paint, pair, palt, panel, panelsi, panelskin, panelsupport, paper, papreg, para5, parabol, parabola, parabolicblad, paraboloid, paradox, paragraph, parallel, parallelpl, paramet, parameterexce, parametervari, paramount, paraplex, parasol, pari, parietal, park, part, partial, particl, particular, particularli, partit, partli, partsnam, partspan, partspe, pass, passag, passeng, passiv, past, path, pattern, payload, peak, pears, peclet, peculiar, penalti, penetr, peng, peopl, per, percent, percentag, perfect, perfectga, perfectli, perfor, perform, perhap, perige, periment, perimet, period, peripher, perman, permeabl, permiss, permit, perpendicular, perpendicularli, perplex, persh, persist, person, pertain, pertin, perturb, pessimist, ph, phase, phenol, phenomena, phenomenolog, phenomenon, philo, philosophi, phosphoresc, photoelast, photograph, photographi, photomultipli, photothermoelast, phugoid, phy, physcal, physic, physiolog, pibal, picard, pictur, piec, pierci, pilot, pimpl, pin, pincreas, pindroh, pinkerton, pipe, piston, pistonanalog, pistontheori, pitch, pitchingmo, pitchup, pitot, pitotstat, pivot, place, placehold, plai, plain, plan, planar, planck, plane, planeload, planestrain, planestress, planet, planetari, planetocentr, planform, plant, plasma, plastic, plasticityreduct, plate, plateau, plateglass, platinum, plausibl, pli, plot, plu, plug, plume, plung, pneumat, podmount, poetic, pohlhausen, poincarelighthillkuo, poind, point, pointednos, pointfunct, poiscuil, poiseuil, poisson, polar, polarcontrol, polarregion, polish, polyatom, polyaxi, polycrystallin, polygon, polym, polynomi, polystyren, polytechn, ponderomot, poor, popular, popularli, pore, porou, portion, portiou, pose, posit, possess, possibl, possio, postbuckl, postshock, postul, potenti, potentialflow, potentialth, potentiomet, potter, poudr, pound, powel,

power, powerfunct, powerinput, powerlaw, powerpl, pr, pr071, practic, practition, prager, prandtl, prandtlglauert, prandtlmey, prandtlreuss, preasymptot, prebuckl, precaut, preced, precessiontyp, precipit, precis, preclud, predict, predigest, predomin, predominantli, prefer, preheat, preliminari, prematur, premis, premix, prepar, preponder, prerot, prescrib, presenc, present, presentdai, preserv, press, pressur, pressurecorrect, pressuredeflect, pressuredistribut, pressuredrag, pressuregradi, pressureinteract, pressureplot, pressureratio, pressurerecoveri, pressurereynold, pressureris, pressuretyp, preston, prevail, preval, prevent, previou, previous, previouslygiven, prewhirl, price, prikl, primari, primarili, primaryshock, prime, princeton, princip, principl, prior, priori, prism, prismat, probabl, probe, problem, probstein, proc, proce, procedur, proceed, process, processinclud, produc, product, profil, profileieit, profound, program, programm, progress, progressivetyp, prohibit, project, projectil, prolat, promin, promis, promot, prone, pronounc, proof, prooftest, propag, propel, propellerblad, propellerdriven, propellerresearch, propellerslipstream, proper, properli, properti, proport, proportion, propos, proposel, proposit, propound, propuls, propulsionsystem, propulsivejet, protect, protein, proton, prototyp, protrud, protrus, protuber, prove, provid, provis, provision, provok, proxim, ps, pseudotwodimension, psf, psi, psia, psig, psycholog, public, publish, puls, pulserocket, pump, punctur, pure, purpos, pursu, put, puzzl, pv, px, pyramid, pyrex, q, qm, quadrat, quadratur, quadruplet, quadrupol, qualit, qualiti, quantit, quantiti, quantum, quart, quarterchord, quarterinfinit, quartic, quartz, quasi, quasicon, quasicylind, quasicylindr, quasiequilibrium, quasiincompress, quasionedimension, quasispher, quasisteadi, quasiunsteadi, quench, quest, question, quick, quickact, quickli, quiet, quit, quot, quotat, r, r14, r420, r48, r502, r5314, r5906, rabotnov, radar, radartrack, radi, radial, radialband, radian, radiant, radiat, radic, radii, radiu, radiusthick, radom, radon, rae, rae101, rae104, rai, rais, rake, raleigh, ramet, ramp, rand, random, randomli, randomprocess, rang, rankin, rankinehugoniot, rapid, rapidh, rapidli, rapidlyfreez, rarefact, rarefi, rarefiedair, rate, ratecontrol, rategovern, rather, ratio, ration, ratiothat, rayleigh, rayleighritz, rayleightollmien, rayleightyp, re, reach, react, reaction, reactionresist, reactiv, reactor, read, reader, readi, readili, reaffirm, real, realflow, realga, realis, realist, realiz, realli, reanalysi, reanalyz, rear, rearrang, rearward, rearwardexhaust, reason, reattach, receiv, recent, reciproc, recircul, recogn, recognis, recombin, recommend, recompress, record, recours, recov, recover, recoveri, recoverytemperatur, rectangl, rectangular, rectilinear, recur, recurr, recurs, redefinit, reder, redirect, redistribut, reduc, reducedfrequ, reducedmodulu, reducedplasma, reduct, redund, reemphas, reenter, reentrant, reentri, reentrytyp, reestablish, reexamin, ref, ref6,

refer, referenc, referenceenthalpi, refin, refinementthi, reflect, reflectedshock, reflex, reformul, refract, refractori, regain, regard, regardless, regim, region, regionsan, regist, regular, reichardt, reimping, reinforc, reinvestig, reiss, reissner, reject, rel, relai, relat, relationship, relativedens, relativist, relax, releas, relev, reli, reliabl, reliev, remain, remaind, remark, rememb, remot, remov, render, reorbit, rep, repair, repeat, repercuss, repetit, replac, report, repres, represent, reproduc, requenc, request, requir, research, researchtyp, researchvehicl, resembl, reserv, reservoir, reshotko, residu, resili, resin, resist, resler, resolidif, resolut, resolv, reson, resort, resourc, respect, respond, respons, rest, restor, restrain, restraint, restrict, result, resultantforc, retain, retard, retrorocket, retroveloc, return, rev, reveal, revers, reverseflow, revert, review, revis, revolut, rewrit, reynold, reynoldsnumberdepend, rf, rft18, rheolog, rhombic, rib, ribbon, ribskin, riccati, richmond, riddel, ridg, right, rigid, rigidbodi, rigidli, rigor, ring, ringstiffen, ringw, riolat, rippl, rise, risk, ritz, rivet, rlx, rm, roar, rocket, rocketborn, rocketchamb, rocketexit, rocketjet, rocketjetexit, rocketlaunch, rocketoff, rocketon, rocketpropel, rod, roger, rogh, roi, role, roll, rolledup, rollingmissil, rollingup, rollup, room, roomtemperatur, root, rootmeansquar, rose, rotari, rotat, rotation, rotationallysymmetr, rotor, rott, rough, roughen, roughli, round, roundedentr, roundnos, routhhurwitz, routin, row, royal, rsult, rt, rubesin, rudimentari, rule, run, rungekutta, ruptur, russian, rx, s, s1, s2, safe, safeti, sai, said, sail, sake, sakurai, salient, salmon, salt, same, sampl, sand, sandgrain, sandpap, sandwich, sandwichtyp, sanger, satelit, satellit, satellitessputnik, satisfact, satisfactori, satisfactorili, satisfi, saundersro, save, scalar, scale, scan, scarc, scarshaack, scatter, schemat, scheme, schlicht, schlieren, schlierenphotomultipli, schmidt, schoenherr, schubauer, schuh, schultzgrunow, schwarz, sci, scienc, scientif, scientist, scope, screen, scruton, sea, seal, sealevel, sealingair, sear, search, season, seban, sec, secant, second, secondari, secondaryflow, secondli, secondord, section, sector, sectori, secur, sediment, sedov, see, seed, seek, seem, seen, segment, seidel, select, selfbalanc, selfconsist, selfcontain, selfgener, selfinduc, selflumin, selfpreserv, selfsimilar, selfsustain, semialgebra, semiangl, semiapex, semiballistictyp, semicircl, semicircular, semiconverg, semidiamet, semiempir, semiincompress, semiinfinit, semimajor, semispan, semispantochord, semivert, semivertex, semivertexangl, senior, sens, sensibl, sensit, sensor, separ, separatedflow, separationfre, separationi, septemb, sequel, sequenc, ser, serbin, seren, seri, seriou, serious, serv, servic, servo, sesir, set, setup, seven, seventhdegre, seventhpow, sever, severli, sextic, shadow, shadowgraph, shaft, shaftmount, shall, shallow, shallowshel, shank, shanlei, shanleyto, shape, shapiro, sharp, sharpcorn, sharpedg, sharpli, sharpnos, sharpplat, sharptip, shear, sheara, shearingstress, shearlay, shearstress, sheath, shed, sheet, shell, shelter, shelteredsid,

shercliff, shesterikov, shield, shift, ship, shock, shockboundari, shockboundarylay, shockboundarylayerinteract, shockcompress, shockdetach, shockdisplac, shockexpans, shockgener, shockinduc, shocklay, shockless, shockprocess, shocksepar, shockshap, shockstandoff, shocktub, shockwav, shockwaveboundarylay, shockwaveveloc, short, shortcom, shorten, shorter, shortest, shortli, shortlifetim, shortperiod, shortskirt, shorttim, should, shoulder, show, show1how, shown, shroud, shuffl, sibulkin, side, sideforc, sidejet, sideslip, sidewal, sidewash, sight, sign, signal, signaltonois, signific, significantli, sigular, silenc, silica, similar, similari, similarli, similitud, simmon, simpl, simpler, simplest, simplewav, simpli, simplic, simplif, simplifi, simplysupport, simul, simultan, simultaneouslyattain, sin, sinc, sine, singl, singleand, singlebai, singlebeam, singledegreeoffreedom, singleel, singleintegr, singlepass, singlepl, singlepoint, singlerot, singlerotor, singlestag, singlestep, singletyp, singlevalu, singlewedg, singli, singular, sink, sinusoid, sir, siren, situat, six, sixdegreeoffreedom, sixfigur, sixth, sixthdegre, sizabl, size, sizeabl, skan, sketchi, skew, skewedparabol, skewedparabolicblad, skill, skin, skincool, skinfrict, skinpanel, skinstiffen, skip, skirt, slab, slender, slenderairfoil, slenderbodi, slendertail, slenderw, slew, slice, slide, sliderbear, slighlti, slight, slightli, slip, slipflow, slipstream, slope, slopecompat, slot, slottedflap, slow, slower, slowli, slr, slug, small, smallamplitud, smalldeflect, smalldiamet, smalldisturb, smalleccentr, smaller, smallest, smalliless, smallperturb, smallscal, smallshear, smell, smith, smoke, smooth, smoothli, sn, snow, so, soak, soc, socal, societi, sodium, sodiumlin, soft, solar, sole, solid, solidbodi, solidconstruct, solidfuel, solidpropel, solubl, solut, solutioni, solv, someth, sometim, somewhat, somewher, sonic, sonicboom, sonicpoint, sonicwedg, soon, sophist, soret, sort, sought, sound, soundattenu, soundemit, soundingrocket, soundpressur, soundsourc, sourc, sourcesink, southwel, space, spacecraft, spacevehicl, spacewis, span, spanload, spanwis, spar, spark, sparkschlieren, spatial, speak, speci, special, specialis, specif, specifi, specificheat, specimen, spectacular, spectra, spectral, spectrograph, spectrum, specular, speculartyp, speed, speeddistribut, spenc, speric, sphere, spherecon, spheric, sphericalatmospher, sphericalcon, sphericallyblunt, spheroid, spike, spikednos, spillag, spin, spindleshap, spinner, spiral, spirit, spite, split, splitter, splittervan, spoken, spontan, spot, spragu, sprai, spread, spreiter, spring, spuriou, sq, sqft, squar, squareedg, squareplanform, squareroot, squir, srn1, stabil, stabl, stack, staff, stage, stageload, stagematch, stagestack, stagger, stagnant, stagnat, stagnationenthalpi, stagnationlin, stagnationpoint, stagnationpressur, stagnationtofreestream, stagnationtowal, stainless, stainlesssteel, stall, stallflutt, stalllimit, stand, standard, standoff, standpoint, stanton, start, state, statement, stateoftheart, static, staticpressur, staticpressureris, staticthrust, statictotot, station,

stationari, statist, statisticalmechan, stator, statu, steadi, steadili, steadyflow, steadymot, steadyst, steam, steamlin, steamturbin, steel, steep, steepest, stefanboltzmann, stein, stem, step, stepbystep, stepdown, stepwis, stewartson, stewartsonillingworth, stiff, stiffen, still, stimul, stimulu, stine, sting, stingcon, stingmount, stipul, stochast, stoke, stoker, stokess, stol, stone, stonecyph, stoni, storag, store, straight, straightedg, straightsid, straightthrough, strain, strainanalysi, straindisplac, straingag, straingaug, straintim, strang, stratagem, stratford, stratiform, streak, stream, streamfila, streamhav, streamlin, streamsid, streamtowal, streamtub, streamwis, strength, strengthen, stress, stressdeflect, stressstrain, stressstraintemperaturetim, stretch, stretchedmembran, strictli, strike, stringer, stringertwist, strip, stripanalysi, striptheori, stroboscop, strong, stronger, stronginteract, strongli, strongshock, strouhal, struck, structur, structuralload, strut, studi, studieddash, studiesdash, studiesexperiment, sturmliouvil, sub, subarc, subcasethat, subcommitte, subcor, subcrit, subdivis, subject, sublay, sublim, submerg, submit, subperige, subroutin, subscript, subsequ, subsidiari, subson, subsoniclift, substanti, substitut, subtend, subtract, succeed, success, successfulli, such, suck, suction, sudden, suddenfreezingof, suddenli, suffer, suffici, suffix, sugarscoop, suggest, suit, suitabl, sum, summar, summari, summaris, summat, superaerodynam, supercircular, supercrit, superfast, superfici, superimpos, superior, superpos, superposit, superscript, supersed, superson, supersonicaircraft, supersonicairfoil, supersonicflow, supersonichyperson, supersonicwak, supplement, supplementari, suppli, supplystream, support, suppos, supposedli, supposit, suppress, sure, surfac, surfaceheat, surfaceheattransf, surfacepressur, surfaceshear, surfacetab, surfacetemperatur, surfaceveloc, surg, surpass, surpris, surprisingli, surround, survei, suscept, sustain, sutherland, sutton, swallow, sweatcool, sweep, sweepback, swept, sweptback, sweptbackw, sweptforward, sweptw, swirl, switch, symmetr, symmetri, symposium, syng, synthes, synthesi, system, systemat, systemsbestim, t, tab, tabl, tabul, tabular, tacitli, tail, tailbodi, tailboom, tailinterfer, tailless, tailor, tailoredinterfac, tailplan, tailwind, tain, take, taken, takeoff, talbot, tamada, tan, tang, tangenc, tangent, tangentcon, tangenti, tangentmodulu, tangentwedg, tangentwedgeapproxim, tank, tao, tap, taper, taperedplanform, target, task, taxiingturn, taylor, taylormaccol, tech, technic, techniqu, technolog, tediou, teeth, teflon, telegraph, telemet, temperatur, temperaturedepend, temperatureedg, temperaturefield, temperaturei, temperatureload, temperatureris, temperaturetim, tempratur, ten, tend, tendenc, tensil, tension, tensor, tent, term, termin, terminolog, termwis, terrain, terrestri, test, testedbetween, testflow, testtheori, tetrachlorid, text, th, than, thedens, theequilibriumparamet, theirworstvalu, themselv,

then, thenc, thenewtoniantheori, theodorsen, theorem, theoret, theoreticalbuckl, theori, theoryeg, theoryon, theorythat, thereaft, therebi, therefor, therefrom, thereof, thermal, thermalboundarylay, thermalexpans, thermalfatigu, thermallay, thermalshock, thermalstress, thermalstressfatigu, thermaltomomentum, thermoaeroelast, thermochem, thermocoupl, thermodynam, thermomechan, thermomet, thermopropuls, these, thesecond, thesi, thesolar, theta, thick, thicken, thicker, thicknesschord, thicknessdiamet, thicknesstochord, thicknesstoradiu, thickwal, thin, thinfilm, thing, think, thinner, thinplat, thinw, thinwal, third, thirdli, thirdord, thirteen, thn, thoma, thorough, thoroughli, those, though, thought, threaten, three, threebar, threebodi, threedimension, threedimensionali, threepoint, threewav, threeyear, threshold, throat, throttl, through, throughout, throw, thrown, thrust, thrustvector, thu, thwait, thwaitess, tical, tietjen, till, tilt, tiltw, time, timeand, timeaverag, timedepend, timederiv, timehistori, timeindepend, timevari, timewis, timoshenko, ting, tion, tional, tip, titan, titl, tn, tne, tni, to, toa, todai, togeth, told, toler, tollmien, tollmienschlicht, tomotika, too, took, tool, top, topic, torda, toricon, toriconic1a, torispher, toroid, torqu, torsion, torsioncontrol, toru, total, totalangl, totalhead, totalpressur, totaltailassembl, touch, toward, townend, townsend, toxic, trace, track, tractabl, traction, tractor, tradit, trail, trailingedg, trailingedgetip, trailingvortex, trailsi, trajectori, transamermathsoc33, transcend, transcendent, transduc, transfer, transfn, transform, transient, transit, transitionfix, transitionrevers, transitiontrigg, translat, translatori, transmiss, transmit, transon, transonicbump, transonicflow, transonictunnel, transpar, transparentwal, transpir, transpirationcool, transport, transportairplan, transtabl, transvers, transversecurvatur, transversewav, trapezoid, travel, travers, treat, treatis, treatment, trefftz, trefitz, trend, tri, trial, trialanderror, triangl, triangular, triangularw, tribut, trick, trigonometr, trim, trip, tripl, triplevalued, trochoid, troubl, troublesom, TRUE, truli, truncat, truth, tsien, tsion, tube, tubesth, tubular, tuft, tumbl, tungsten, tunnel, turbanc, turbin, turbojet, turbojetpow, turbomachin, turbul, turbulenceintens, turbulentboundarylay, turbulentflow, turbulentveloc, ture, turn, twenti, twentyf, twentyon, twice, twinengin, twinpropel, twist, two, twoand, twobodi, twocompon, twodiagram, twodimension, twodimensionalairfoil, twoelement, twofold, twoinch, twolay, twolob, twomod, twoparamet, twopoint, twostag, twothird, twouniform, tx, type, type1ar, typic, typifi, typograph, typographi, u, u1, u2u1, uhf, uk, ultim, ultracentrifug, ultraviolet, unabl, unaccompani, unaffect, unanticip, unavoid, unbalanc, unbank, unblunt, unbound, unbuckl, uncamb, uncertain, uncertainti, unchang, unconserv, unconstrain, uncontrol, uncool, uncorrect, uncoupl, uncoupledmod, undamp, undeform, under, underestim, underexpand, underexpans, undergo, undergon, underli, undermassbalanc, underneath, undershoot, undersid, understand, understood, undersurfac, undertaken, undertook,

undesir, undetermin, undissoci, undisturb, undoubtedli, undroop, unduli, unequ, uneven, unexpect, unexpectedli, unexplain, unfamiliar, unfavor, unfavour, unfil, unfir, unflang, unfold, unfortun, unhappi, unheat, uniaxi, unidirect, unidirection, unif, unifi, uniform, uniformflow, uniformli, uniformsect, uniformstream, unimod, unimport, unintention, union, uniqu, unit, unitari, uniti, univac, univer, univers, unknown, unless, unlik, unlimit, unload, unman, unmodul, unnecessari, unorthodox, unperturb, unpow, unpressur, unpublish, unreal, unrealist, unrelativist, unresolv, unrestrain, unrestrict, unretard, unsatisfactori, unsepar, unsolv, unspecifi, unstabl, unsteadi, unsteadyflow, unsteadylift, unstiffen, unstress, unsupport, unswept, unsymmetr, untap, unten, untest, until, untrim, untwist, unusu, unyaw, up, upflow, upon, upper, upperand, upperatmospher, uppersurfac, upstream, upward, upwash, ur, urgent, us, usa, usabl, usafsponsor, usafsupport, usag, usedand, usefulli, user, ussr, usual, utia, util, utilis, utilz, ux, uxyi, uxysgn, v, va, vacuum, valid, valu, valuabl, valueless, valv, van, vane, vanguard, vanish, vanishingli, vapor, vaporscreen, vapour, vari, variabl, variablecapacit, variabledens, variablegeometri, variablepressur, variabletemperatur, variablethick, variant, variat, variationsh180, varieti, variou, various, vector, vehicl, vehiclelength, veiociti, veloc, velocitycompon, velocitydistribut, velocityenthalpi, velocityi, velocityperimet, velocityprofil, vent, venu, veociti, verfi, veri, verif, verifi, versa, versatil, version, versu, vertex, vertexcent, vertic, verticalgust, verticaltail, verticaltakeoffandland, vessel, vgroov, via, vibrat, vibration, vibrationallyfrozen, vibratori, vice, vicin, view, viewpoint, vii, violat, violent, virtual, viscid, viscoelast, viscos, viscositytemperatur, viscou, viscousinteract, viscouslay, visibl, vision, visual, visualflow, visualis, vital, viz, vlasov, volterra, volum, volumetr, von, vortex, vortexsheet, vortextub, vortic, vorticityinteract, voyag, vs, vshape, vtol, vy, vz2, w, w065, w1, wa, wagner, wai, waist, wake, wakeflow, wakelik, wakethen, walkden, wall, wallcool, wallmount, wallpressur, wallproperti, walltemperatur, walltoambi, walltofreestream, walltostagn, wanlass, want, ward, warhead, warmer, warn, warp, warrant, wash, wassermann, water, wave, wavedrag, wavefront, wavelength, wavelength00005, wavenumb, wavesdash, wavi, wax, wb, we, weak, weaken, weaker, weakli, weapon, web, wedg, wedgeflow, wedgeshap, wedgetyp, weigh, weight, weightflow, weighttoarea, weinstein, weissing, weitbrecht, well, wellestablish, wellknown, wendt, were, wet, whatev, wheel, whenev, wherea, wherebi, wherein, wherev, whether, whichev, while, whilst, whirl, whisker, white, whitehead, whitham, whithamwalkden, whole, whose, wide, wideflang, widen, wider, widespread, width, widthlength, wilei, william, wilson, wind, windon, window, windstream, windtunnel, windward, wing, wingbodi, wingbodytail, wingbodytailplan, wingfin, wingflow, wingfuselageshel, winglik, wingpropel, wingsect, wingstal, wingtail, wingtip, wingwith, winni, wire, wissler, withdraw, within, without,

withstand, wkb, womerslei, wont, wood, woodgat, word, work, worker, workingsect, world, worsen, worst, worth, worthi, worthwhil, would, woven, wright, wrinkl, write, writer, written, wxy, x, x0, x10, x15, x600, xaxi, xcoordin, xdirect, xenon, xrai, xtransform, xy, y, y0, y1, y125, y2, yarymovych, yaw, yawedcon, yawedcylind, yawi, yaxi, year, yeh, yeild, yet, yield, york, young, yuan, yy, z, zakkai, zamm, zbrozek, zero, zeroangleofattack, zeroflow, zeroinject, zerolift, zeroord, zeropressuregradi, zeroth, zeroyaw, zhukhovitskii, zone, zoom, zplane, zsection, zuk, zurich **}**

Vocabulary: {abbreviated, ability, ablatedlength, ablating, ablation, ablationrate, ablative, able, ablev, about, about053, above, abovementioned, abrupt, abruptly, abruptstall, absence, absent, absolute, absorbed, absorbing, absorption, abstract, abundantly, academic, accelerated, accelerates, accelerating, acceleration, accelerationtolerance, accelerator, accelerometer, accentuated, acceptability, acceptable, acceptably, acceptance, accepted, accessible, accidental, accommodate, accommodated, accommodation, accompanied, accompanies, accompany, accompanying, accomplish, accomplished, accord, accordance, according, accordingly, account, accountable, accounted, accounting, accrue, accumulated, accumulation, accuracy, accurate, accurately, acetate, achievable, achieve, achieved, achieving, ackeret, ackerets, acoustic, acoustical, acoustically, acquire, acquired, acquisition, acr, acrodynamic, across, acrothermochemistry, acrothermoelasticity, act, acted, acting, action, activation, active, activity, actual, actually, actural, adam, adaptable, adaptation, adapted, add, added, addendum, adding, addition, additional, additive, adequacy, adequate, adequately, adiabatic, adiabaticwall, adjacent, adjacentequilibriumposition, adjoining, adjoint, adjust, adjustable, adjusted, adjusting, adjustment, administration, admissible, admit, admits, admitted, admitting, admixture, adopted, adsorption, advance, advanced, advancediameter, advancing, advantage, advantageous, advent, adverse, advisory, advocated, aec, aeolotropic, aerfoils, aerialground, aero, aero2441, aeroballistics, aerocosmonautics, aerodynamic, aerodynamically, aerodynamiccenter, aerodynamiccentre, aerodynamics, aerodynamicthermoelastic, aerodynamieist, aeroelastic, aeroelasticity, aerofoil, aeronautical, aeronautics, aeroplane, aerothermal, aerothermochemical, aerothermodynamic, aerothermoelastic, affect, affected, affecting, affinely, affinity, affirmative, afford, afforded, affords, aforementioned, afresh, aft, after, afterbodies, afterbody, afterbodyjetnozzle, afterburner, afterburning, afterflow, again, against, age, agency, ago, agree, agreed, agreeing, agreement, agrees, ahead, aid, ailcron, aileron, ailerontab, aim, aimed, air, airborne, aircraft, aircraftenginepropeller, aircrafttype, aircushion, airdensity, airflow, airfoil, airforce, airframe, airinduction, airit,

airjet, airliner, airload, airloads, airplane, airreceiver, airscrew, airspeed, airstream, akin, al, alfven, algebraic, aligned, allen, alleviated, alleviating, alleviation, allmovable, allmovablecontroltype, allow, allowable, allowance, allowed, allowing, allows, alloy, alloys75st6, allround, alluded, almen, almost, alone, along, already, also, alter, alteration, altered, altering, alternate, alternately, alternating, alternative, alternatively, alters, although, altitude, altogether, aluminium, aluminum, aluminumalloy, always, ambient, ambiguity, amenable, america, american, ames, ammonium, among, amongst, amount, amounted, ample, amplification, amplified, amplifier, amplifying, amplitude, amply, amr, analog, analogous, analogously, analogue, analoguous, analogy, analyse, analysed, analyser, analyseseg, analysis, analytic, analytical, analytically, analyticially, analyzable, analyze, analyzed, analyzer, analyzes, analyzing, and058, and2how, andabrespectively, andor, anemometer, angle, angleofattack, angular, angularly, anh, anhedral, anideal, anisotropic, anisotropy, annex, announces, annual, annul, annular, annulardisk, annulus, anomalous, anomaly, another, anovementioned, answer, answered, antielastic, antisymmetric, antisymmetrical, anyway, aob, apart, apex, apexangles, apogee, apparatus, apparent, apparently, apparentmass, appear, appearance, appeared, appearing, appears, appended, appendix, appl, applicability, applicable, application, applied, applies, apply, applying, appraisal, appraised, appraisement, appraoch, appreciable, appreciably, appreciated, approach, approached, approaching, appropriate, approx, approximate, approximated, approximately, approximates, approximating, approximation, approximationie, apropriate, ar, ara, arbitrarily, arbitrary, arc, arcdischarge, archeated, ardc, area, areamach, areamean, argon, argonfree, argued, argument, arise, arisen, arises, arising, arithmetic, arithmetical, arm, armenakas, around, arranged, arrangement, arrest, arrhenius, arrival, arrive, arrived, arriving, arrowwing, art, article, artifice, artificial, artificially, arylayer, ascending, ascertain, ascertained, ascribed, aside, asimplified, ask, asme, aspect, aspectratio2, aspectratio6, asreceived, ass, assembled, asserted, assessed, assessing, assessment, assigned, assist, assistance, associated, association, assortment, assume, assumed, assumes, assuming, assumption, assure, astronautics, astrophysics, asymmetric, asymmetrical, asymmetry, asymptote, asymptotic, asymptotically, at, atlarge, atm, atmosphere, atmosphereie, atmosphererather, atmospheric, atom, atomic, atommolecule, attach, attached, attachedflow, attachment, attack, attacked, attacking, attain, attainable, attaindd, attained, attaining, attainment, attempt, attempted, attendant, attened, attention, attenuating, attenuation, attitude, attract, attractive, attributable,

attributed, augmentation, augmented, august, aural, auspex, author, authority, autocorrelation, automatic, automatically, auxiliary, availability, available, avaluated, avenue, average, averaged, averaging, avoid, avoidance, avoided, avoiding, avoids, avove, avro, away, ax, axial, axialflow, axialforce, axially, axiallysymmetric, axiallysymmetrical, axialthrust, axis, axisymmetric, axisymmetrical, azimuthal, b, back, backed, background, backing, backup, backwardfacing, bagley, bakanov, balance, balanced, balancing, ballistic, ballistics, ballistictype, balsa, ban, band, bandpass, bandwidth, bang, bank, bar, bare, barrel, barrier, base, based, baseforward, basepressure, basetojet, basetype, basic, basically, basicflow, basin, basing, basis, batchelor, batdorfs, bay, bc, beam, beane, bear, bearing, beat, became, because, becausewith, become, becomes, becoming, bed, bedford, before, began, begin, beginning, begs, begun, behave, behaved, behaves, behavior, behaviorccontrolsystem, behaviour, behind, being, belief, believe, believed, believing, bell, belleville, belltype, belong, belongs, belotserkovskii, belotserkovskiis, below, belt, bend, bending, bendingmoment, bendingtorsion, bendingtotorsion, beneath, beneficial, benefit, bent, ber, bergdolt, berger, bernoullieuler, berthelots, bertram, bertrams, beskin, bessel, best, bestfit, better, between, beveled, beyond, beyween, bibliography, biconvex, bifurcated, bifurcation, biharmonic, billowing, bimetallic, bimolecular, bimolecularexchange, binary, binarymixture, biot, biots, birnbaums, bisector, blade, bladesurface, bladetoblade, blading, blasius, blasiuss, blast, blastproducer, blastwave, bleed, bleich, blended, block, blockage, blocking, blowdown, blowdowntype, blowing, blown, blowout, blue, bluff, bluffafterbody, bluish, blunt, bluntbase, bluntbased, bluntbody, blunted, blunter, blunting, bluntness, bluntnose, bluntnosed, blunttrailingedge, board, boattail, boattailing, boattails, body, bodyaxis, bodydiametermaximumspan, bodyforce, bodyvolume, bodywing, bogdonoff, boiloff, bolshakov, boltzmann, bomb, bomber, bond, bondpackard, bondstress, bonus, book, boom, booming, boomproducing, boost, booster, bore, borne, bornel, both, bottom, bound, boundary, boundarycondition, boundarylayer, boundarylayercontrol, boundarylayerinduced, boundarylayershockwave, boundarylayertype, boundaryvalue, bounded, bounding, boundwell, bourne, bow, bowshock, box, boxwing, bracket, braking, branch, branchline, brass, braunschweig, breadth, break, breakdown, breaking, breathing, breguet, bridge, bridging, brief, briefly, brightness, bring, brings, british, broad, broadened, broadening, broadspectrum, broke, broken, brooklyn, brought, brown, btu, btulb, bubble, buckle, buckled, buckledpanel, buckling, budiansky, buffeting, build, built, builtup, bulent, bulging, bulk, bulkhead, bullet, buoyancy, buoyant, bureau, burger, buried, buriedfan, burned, burning, burst, busemann, butler, buzz, bycharacteristics, bypass, c, c035, cabin, cal, calcualted, calcualtions, calculate, calculateby, calculated, calculating, calculation, calculus, calculusofvariations, caliber, calibrate, calibrated,

calibration, california, call, called, caloric, calorically, camber, cambered, cambridge, camera, can, canard, cancel, cancellation, cancelled, cannot, canted, cantilever, cantilevered, cap, capability, capable, capacitance, capacity, capillary, caplan, capped, capsule, caravelle, carbon, carbonate, carborundum, care, careful, carefully, caret, carried, carrier, carry, carrying, carter, cartesian, cascade, case, casesone, casing, cast, castiglianos, castolite, catalytic, catalytically, category, catered, cathoderay, cauchy, cause, caused, causing, cavitating, cavitation, cavity, cease, cell, cellular, cellulose, cent, centaur, center, centerbut, centered, centerline, centerofgravity, centerofpressure, centigrade, central, centrally, centre, centrebody, centreline, centresection, centrifugal, centripetal, centroid, certain, certainly, certainty, ceulers, cf, cg, chain, chamber, change, changed, changing, channel, chap, chapman, chapmanenskog, chapmanjouguet, chapmanrubesin, chapter, character, characteristic, characteristically, characteristies, characterize, characterized, characterizes, characterizing, charge, charged, chargedparticledensity, charging, chart, charted, charter, chartsfigs16it, chase, check, checked, chemical, chemically, chemisorption, chemistry, cheng, chengs, chernyi, chesky, chester, chief, chiefly, chien, child, chinaclay, chloride, choice, choke, choked, choking, choleski, choose, choosing, chord, chordwise, chosen, chu, circle, circling, circuit, circuitry, circular, circulararc, circularbladed, circularcone, circularcylindrical, circularity, circulated, circulating, circulation, circulatory, circumference, circumferential, circumlunar, circumscribing, circumstance, cited, civil, ck, claim, claimed, clamped, clampededge, clamping, clamshellshaped, clarified, clarify, clarifying, class, classed, classic, classical, classically, classificaiton, classification, classified, clausing, clausings, clear, clearance, cleared, clearly, climb, climinated, close, closed, closedcontour, closedform, closedjet, closely, closeness, closer, closest, closure, cloud, cm, co, co2, coalescence, coarse, coasting, coating, coauthored, coaxial, cocurrent, code, coefficient, coefstant, coherent, coincide, coincident, coincides, cold, coldair, coldbody, colder, coldwall, cole, collaboration, collaborator, collapse, collapsesin, collapsing, collect, collected, collection, collectively, collision, collisionfree, collocation, colour, column, columncapacity, columnimperfection, columnmaterial, combination, combine, combined, combining, combustible, combustion, combustionheated, combution, come, command, commence, comment, commented, commercial, commercially, committee, common, commonly, communication, compact, companion, company, comparable, comparative, comparatively, compare, compared, comparing, comparison, compatibility, compatible, compensated, compensating, compete, competition, compilation, compiled, complement, complementary, complete, completecompressorstall, completed, completely, completeness, completion, complex, complexity, complicated, complimentary, component, composed, composite, composition, compound, comprehensive, compressed, compressedair, compressibility, compressible, compressibleboundarylayer, compressibleflow, compressiblefluid,

compressiblelaminarboundarylayer, compressing, compression, compressional, compressioncorner, compressive, compressor, compressorsdash, comprise, comprised, comprising, compromise, computation, computational, compute, computed, computer, computing, computingmachine, concave, conceivable, conceivably, conceived, concentrated, concentration, concentric, concept, conception, conceptual, concern, concerned, concerning, concise, concisely, conclude, concluded, concludes, conclusion, conclusively, concocted, concrete, concur, concurrent, concurrently, concurring, condamped, condensation, condense, condensed, condition, conduct, conducted, conducting, conduction, conductioncontrolled, conductionexpansion, conductive, conductivity, conductor, cone, conecylinder, conecylinderflare, conecylinderfrustum, conecylinderfrustumbooster, conecylinders, coned, conefrustum, conehemisphere, conesegment, conespherical, confidence, configuration, confine, confined, confirm, confirmation, confirmed, confirming, confirms, conflict, conflicting, confluent, conform, conformal, conformally, conformaltransformation, conformity, conforms, confused, confusing, congress, conic, conical, conicaldash, conicalflow, conically, conicals, conicalshockexpansion, conidtions, conjecture, conjectured, conjunction, connect, connected, connecting, connection, connects, connexion, consequence, consequent, consequently, conservation, conservationofmomentum, conservative, conservativeness, consider, considerable, considerably, consideration, considered, considereddashthat, consideredideal, considering, considers, consierable, consist, consisted, consistent, consistently, consisting, consists, consolidate, const, constancy, constant, constantarea, constantchord, constantdensity, constantenergy, constanth, constantly, constantpressure, constantproperty, constantsthey, constantstrength, constantstress, constanttemperature, constantwalltemperature, constituent, constitute, constituted, constitutes, constitution, constrained, constraining, constraint, construct, constructed, constructing, construction, consumption, contact, contacting, contain, contained, containing, contains, contaminates, contaminating, contamination, contemplated, content, context, continually, continuation, continue, continued, continues, continuity, continuous, continuously, continuum, continuumflow, continuumtype, contour, contoured, contract, contracting, contraction, contradiction, contrary, contrast, contrasting, contribute, contributed, contributes, contributing, contribution, contributionsviz, control, controlled, controlling, controlsurface, controversy, convect, convected, convection, convectionie, convective, convenience, convenient, conveniently, conventional, converge, convergence, convergent, convergentdivergent, converges, converging, convergingdiverging, converse, conversely, conversion, convert, converted, converting, convex, conviction, convolution, cool, coolant, cooled, cooler, cooling, cooperation, coordinate, coordinated, coordinatetype, cope, coplanar, copper, core, cornell, corner, corollary, corotating, corporation, corpuscular, correct, corrected,

correcting, correction, corrective, correctly, correctness, correlate, correlated, correlating, correlation, correlator, correlograms, correspond, corresponding, correspondingly, corresponds, corridor, corroborate, corrugated, corrugatedcore, cosine, cosmonautics, cost, couette, couettetype, could, coulomb, council, counter, counteracting, counterclockwise, counterpart, counterrotating, counting, country, couple, coupled, coupledmode, coupling, coupon, course, cover, coverage, covered, covering, cowling, cowlingspinner, coworkers, cps, crabtree, crack, cracking, craft, cranknicolson, creased, created, creep, creepbending, creepbuckling, creepingmotion, creeprupture, crest, crew, crinoline, criterion, critical, critically, criticized, crocco, croccolees, croccos, crooked, cropped, croppeddelta, cross, crosscorrelation, crosscoupling, crossdrift, crossed, crossflow, crossflowplane, crossing, crosssection, crosssectional, crosssections, crucial, cruciform, cruciformwing, cruise, cruising, crushed, cubic, cubics, cumbersome, cumulative, cure, curlingup, current, currently, curtain, curvature, curve, curved, curvedbeam, curvedsurface, curvilinear, curving, cushion, cusp, cusped, cussed, customary, cut, cutoff, cutout, cutting, cx, cycle, cyclessec, cyclic, cycling, cylinder, cylinderhemisphere, cylindrical, cylindricalbody, d, d48, d693, daley, damage, damaging, damped, damping, dampinginpitch, dampinginyaw, dampometer, dana, dand, danger, dangerous, dash, dashn, data, date, davy, day, daytime, daytonight, db, dc, de, dead, deadair, deadweight, deal, dealing, dealt, debatable, debye, debyes, decade, decay, decaying, decelerate, decelerated, decelerates, decelerating, deceleration, decelerationlimited, decide, decided, decidedly, decimal, decision, decisively, declassified, declined, decomposed, decomposition, decrease, decreased, decreasing, decrement, deduce, deduced, deducted, deduction, deep, deeper, deepest, deexciting, defect, defence, defference, deficiency, deficit, definable, define, defined, defines, defining, definite, definitely, definition, deflagration, deflected, deflectedslipstream, deflecting, deflection, deflectiontime, deflexion, deformable, deformation, deformed, deforming, defy, deg, degenerate, degraded, degree, degreehalfangle, deionization, deisgn, delay, delayed, delft, delimited, delineated, delta, deltawing, deltawings, demand, demarcation, demonstrate, demonstrated, demonstrates, demonstration, dence, denomination, denote, denoted, denotes, dense, denser, density, densitycan, densityviscosity, dent, depart, department, departs, departure, depend, depended, dependence, dependency, dependent, depending, depends, depicting, depletion, deposit, deposited, depression, depth, derivable, derivation, derivative, derive, derived, derives, deriving, deryagin, descending, descent, describable, describe, described, describes, describing, description, descriptive, descriptively, design, designated, designed, designer, designing, designtype, desirability, desirable, desire, desired, desk, despite, destabilizing, destalling, detached, detachment, detail, detailed, detailthe, detect, detectable, detected, detection, deteriorate, deteriorates, deterioration, determinable, determinant,

determinantal, determinate, determination, determine, determined, determines, determining, detonation, detra, detrimental, deuce, develop, developable, developed, developing, development, developmentit, develops, deviate, deviation, device, devise, devised, devising, devoted, devreased, dewpoint, diagonal, diagram, diam, diameter, diameterthickness, diamond, diamondprofile, diamondshaped, diaphragm, diatomic, dicsovering, dictated, did, dielectric, differ, differed, difference, different, differential, differentiate, differentiates, differentiation, differing, differs, difficult, difficulty, diffuse, diffusely, diffuser, diffusion, diffusive, diffusivity, digit, digital, digitalcomputer, dihedral, dilation, dilute, dimension, dimensional, dimensioning, dimensionless, diminish, diminished, diminishes, diminishing, dioxide, dipole, dirac, direct, directed, direction, directional, directive, directly, directorgeneral, dirichlets, dirt, disadvantage, disagree, disagreement, disappear, disappeared, disappears, disc, discerned, discernible, discharge, discharging, disclose, discontinuity, discontinuous, discontinuouswake, discovered, discovery, discrepancy, discrete, discretefrequency, discretehorseshoevortex, discretetype, discus, discussed, discussing, discussion, disequilibrium, disk, dislocation, dismissed, disparity, dispersion, displaced, displacement, displacementarea, displacing, display, displayed, disposable, disregarded, disregarding, dissertation, dissimilar, dissipation, dissipative, dissociate, dissociated, dissociating, dissociatinggas, dissociation, dissociationrecombination, distance, distancetime, distant, distinct, distinction, distinctly, distinguishing, distort, distorting, distortion, distributed, distributes, distributing, distribution, disturb, disturbance, disturbancewhich, disturbed, disturbing, diurnal, divergence, divergent, diverges, diverging, diverse, diversified, divide, divided, dividing, diving, division, do, doctor, dodecagonal, doe, doing, domain, dome, dominant, dominate, dominated, dominating, done, donnell, donnells, donnelltype, doppler, dorodnitsyn, dorodnitzinhowarth, dorodnitzyn, double, doubled, doublesided, doubleslotted, doublet, doublewedge, doubling, doubly, doubt, doubtful, down, downstream, downstreampropagating, downward, downwards, downwash, downwashes, drag, dragdivergence, dragmodulation, dragrise, dramatic, draped, drastic, drastically, draw, drawing, drawn, drew, driests, drilled, drilling, drive, driven, driver, driving, droop, drooped, drop, dropoff, dropped, drosophila, drum, drumcamera, dry, dryden, dual, dualpropeller, dualrotating, ducing, duct, ducted, ducting, dudx, due, dufour, duplicated, duplicating, duralumin, duration, during, dust, dvl, dy, dyke, dynamic, dynamical, dynamically, dynamicanalogy, dynamicpressure, e, e02, e53h25, ea, eab, each, earlier, early, earth, ease, easier, easiest, easily, easy, eccentricity, echo, eckert, eckerts, economic, economics, economy, ed, eddy, eddyviscosity, edelfelt, edge, edged, edgedisplacements, edgeloaded, edgesto, edgetractions, edgewise, edition, edpm, educational, edward, effect, effected, effective, effectively, effectiveness, effectmay, effectoriginates, efficacious, efficiency, efficiencywere, efficient, efflux, effort, effusion, eg, egat,

egger, eigenvalue, eigenvectors, eight, eighth, eighthorder, einbinder, either, ejector, elaborate, elapsed, elapsing, elastic, elastically, elasticaxis, elasticbehavior, elasticity, electric, electrical, electrically, electricallyheated, electricanalog, electricresistance, electrode, electroformednickel, electrohydrodynamic, electromagnetic, electron, electronic, electronion, electrostatically, elegant, element, elemental, elementary, elevated, elevatedtemperature, elevation, elevator, eliminate, eliminated, eliminates, eliminating, elimination, elliott, ellipse, ellipsecylinder, ellipselike, ellipsoid, ellipsoidal, elliptic, elliptical, elliptically, ellipticity, elsewhere, embedded, embrace, embraced, embracing, embryonic, emerges, emission, emissivity, emitted, emitting, emmons, emphasis, emphasising, emphasized, emphasizes, empirical, empiricalintermediate, empirically, employ, employed, employing, employment, enable, enabled, enables, ence, encircling, enclosed, enclosing, encompass, encompassed, encompassing, encounter, encountered, encouraging, end, endeavour, endorsed, endplate, endpoint, endshortening, endurance, energy, energymethod, energyrequirement, enforced, engaged, engesser, engine, engineer, engineering, enginemount, enginepropeller, england, enhance, enhanced, eniac, enjoy, enjoys, enlarge, enlarges, enlightening, enormously, enough, enquiryto, ensuing, ensure, entail, enter, entering, enters, enthalpics, enthalpy, enthalpyused, enthalpyvelocity, entire, entirely, entirety, entitled, entrained, entrainment, entrance, entropy, entropylayer, entry, envelope, environment, environmental, envisaged, epoxy, eq, equal, equality, equally, equalspan, equate, equating, equation, equatorial, equicohesive, equilateraltriangle, equilibrate, equilibrium, equipment, equipped, equivalence, equivalent, equivalentcone, equivalently, erature, erdmannweierstrass, erfc, erickson, eroded, erosion, erosive, erratic, error, errorintegral, errorssdof, escape, especially, essence, essential, essentially, establish, established, establishing, establishment, estimate, estimated, estimating, estimation, et, etal, etc, eter, ethylene, ethyleneheated, eucken, euckenvalue, euler, eulerian, eulerlagrange, ev, evaluate, evaluated, evaluates, evaluating, evaluation, evaporate, evaporates, evaporation, even, event, eventual, eventually, eversustime, every, everywhere, evidence, evidenced, evident, evidently, evolve, evolved, evvard, exact, exactly, exaggeration, examinable, examination, examine, examined, examines, example, exceed, exceeded, exceeding, exceeds, excellent, except, exception, exceptional, exceptionally, excess, excessive, excessively, exchange, exchanger, excitation, excite, excited, excites, exciting, excluded, excluding, excrescence, excused, exercise, exert, exerted, exerts, exhaust, exhausted, exhausting, exhaustive, exhaustpressure, exhibit, exhibited, exist, existed, existence, existing, exists, exit, exitarea, exiting, exotic, expand, expanded, expanding, expands, expanse, expansion, expansioncontrolled, expansiondeflection, expansionturning, expansionwave, expect, expectation, expected, expects, expended, expenditure, expense, experience, experienced,

experiencing, experiment, experimental, experimentalfailure, experimentally, experimenter, explain, explained, explaining, explains, explanation, explicit, explicitly, exploit, exploited, exploration, exploratory, explore, explored, exploring, explosion, explosive, exponent, exponential, exponentially, exponentiallyficients, expose, exposed, exposition, exposure, expounded, express, expressed, expressible, expressing, expression, extend, extended, extending, extends, extensiblechord, extension, extensional, extensive, extensively, extent, exterior, external, externalflow, externally, externalskin, extinction, extra, extrapolated, extrapolating, extrapolation, extremal, extreme, extremely, eye, f, f0, f100, f2layer, f40umerical, f8u3, fa, fabric, fabricated, fabrication, face, faced, facet, facilitate, facilitates, facilitating, facility, facing, fact, factor, factorspropulsive, fage, fail, failed, failing, fails, failure, fair, faired, fairly, fales, falkner, falknerskan, fall, falling, familiar, family, fan, far, farfield, farflow, farther, fashion, fast, fastened, faster, fat, fatigue, favor, favorable, favorably, favourably, fay, fd, feasibility, feasible, feature, featuring, fed, feedback, feeding, feel, feldman, fell, felt, ferri, ferris, fewer, ff, fiber, fibrous, fictitious, fictitiously, field, fifth, fifthdegree, fifty, fiftyone, fig, fighter, fightertype, figure, filament, fill, filled, filling, film, filter, filtering, fin, final, finally, financial, find, finding, fine, finely, fineness, finenessratio, finenessratio271, finenessratiobeen, finest, finish, finite, finitedifference, finitedisplacement, finitespan, finitethickness, finned, finstabilized, fire, firing, firingrange, firm, firmer, first, firstorder, fissionthe, fit, fitted, five, fivestage, fiveterm, fix, fixed, fixedgeometry, fixedpitch, fixing, fk, flame, flange, flap, flapped, flapping, flare, flarecylinder, flared, flash, flat, flatbased, flatfaced, flatheaded, flatness, flatnosed, flatpanel, flatplate, flattop, flex, flexibility, flexible, flexibly, flexural, flexure, flight, flightpath, flighttest, fllayer, floating, floatingelement, flocculent, floor, floorpressure, flow, flowdash, flowfield, flowie, flowin, flowing, flowmeter, flowmeters, flown, flownot, flowsthat, flowvisualization, fluctuates, fluctuating, fluctuation, flugge, flugges, fluid, fluidcylinder, fluiddynamic, fluidflow, fluidized, fluidpressure, fluidsolid, flutter, flutterare, fluttered, fluttermode, flutternamely, flutterprevention, flutterspeed, flux, fly, flying, fn, focus, focused, focusing, fog, foil, folding, follow, followed, following, follows, foot, footing, force, forceand, forced, forcedeformation, forcefree, forcetest, forcible, fore, forebodies, forebody, forecast, forecasting, foredrag, forefront, foregoing, foreign, foreknowledge, form, formal, formally, formation, formed, former, forming, formula, formulate, formulated, formulating, formulation, formulism, fort, forth, fortythree, forum, forward, forwardacceleration, forwardexhausting, forwardfacing, forwardflight, forwardfuselage, forwardfuselagesection, found, foundation, founded, four, fourcomponent, fourengine, fourhole, fourier, fourpole, fourth, fourthdegree, fourthorder, fourwave, fpre, fps, fr, fraction, fractional, fracture, fralich, frame, framed, framework, france, fredholm, free, freeconvection, freedom, freefield, freeflight, freeflown, freefree, freeing, freejet, freelysupported, freeman, freemixing, freemolecule, freeshear, freestream, freestreaminjectant, freevortex, freeze, freezing, freon, freon12, frequency, frequencyband, frequencyshifting, frequencythe, frequently, friction,

frictional, frictionless, friedman, friedrichs, fringe, from, front, frontal, frozen, frozenflow, fruit, fruitful, frustration, frustum, ft, ftsec, fuel, fuelto, fulfilled, fulfillment, full, fuller, fullscale, fullskirted, fullspan, fully, fullyexpanded, function, functional, fundamental, fundamentally, furnace, furnishes, furnishing, further, furthermore, fused, fuselage, future, fx, fz, g, ga, gage, gain, gained, galcit, galerkin, galerkins, gamma, gap, garabedians, gardless, garrick, gas, gascous, gasdynamic, gasdynamical, gasdynamics, gaseous, gasmixture, gathered, gauge, gauged, gauss, gaussian, gaussseidel, gave, geckelers, geiger, general, generalised, generality, generalization, generalized, generalizednewtonian, generalizes, generalizing, generally, generate, generated, generates, generating, generation, generator, genuine, geodesic, geoffrey, geometric, geometrical, geometrically, geometrics, geometry, geophysical, gerard, german, gershuni, get, getting, gibbsdalton, giese, give, given, giving, glass, glassy, glauert, glauerts, glide, glider, gload, globule, glycerinwater, go, goal, goldstein, goldsteins, good, goodier, gorcum, gorcums, gordon, gortler, gothic, govern, governed, governing, governs, grad, grade, graded, gradient, gradual, gradually, graham, grain, gramsc, grand, granulartype, graph, graphical, graphically, graphite, grashof, grasshofs, gravalos, gravel, gravitational, gravity, gravitywave, grazing, great, greater, greatest, greatly, green, grid, gridnor, gridwork, grimminger, grober, gross, grossman, grossweight, ground, groundeffect, groundheight, groundpressure, groundreflection, group, grouped, growing, grows, growth, guaranteed, guidance, guide, guided, gun, gupta, gust, gw, gyration, gyroscope, gyroscopic, h, h2, h2o, ha, haag, had, hadamards, half, halfangle, halfangles, halfcone, halfheights, halfjet, halfmodel, halfmodels, halfrange, halfspace, halfway, halfwing, hall, hallcurrent, halstead, halved, hammerhead, hammitt, hampered, hand, handicap, handle, handled, handley, handling, hankel, hansens, hantzsche, happen, happened, hard, hardening, hardly, hardware, harmonic, harmonically, harris, hartmann, hartree, hartrees, hartreewomersley, hash, hasimoto, hastening, haveg, havelock, having, hay, hayes, hazard, head, heading, heaslet, heat, heatabsorption, heatbalance, heatconduction, heated, heater, heatflow, heatflux, heating, heatingrate, heatinput, heatinsulated, heatsink, heattransfer, heavier, heaving, heavy, height, heighth, heightthickness, heightto, heighttochord, heighttojet, heimel, heimenz, heisenberg, held, helical, helicopter, heliocentric, helium, heliumdriven, helmholtz, help, helpful, hemisphere, hemisphereconecylinder, hemispherecylinder, hemispherical, hemispherically, hemisphericallynosed, hemisphericalnosed, hemispheroidal, hence, hencky, herein, heretofore, hero, herrmann, heterogeneous, hexagonal, hg, hicks2, hidalgo, high, highaltitude, highaspectratio, highbeta, highdrag, highenergy, highenthalpy, higher, higherorder, highest, highfrequency, highg, highlift, highly, highlycooled, highpowered, highpressure, highpressureratio, highspeed, highstagnationtemperature, highsupersonicspeed, hightemperature, highvelocity, himself, hindered, hinge, hingeaxis, hinged, hingemoment, hirschfelders, hirshfelder, hise, historically, historics, history, hit, hitherto, hitting, hk, hm,

hodograph, hoff, hoffmanteller, hoffs, hogging, hold, holder, holding, hole, holland, hollow, hollowcylinder, homann, home, homing, homogeneous, homogenous, honeycomb, hoop, hope, hoped, hopeless, hopelessly, hopf, horizontal, horizontally, horizontaltail, horseshoe, hoshizaki, hosokawas, hot, hotbody, hotfatigue, hotgas, hotter, hotwire, hour, housefly, housing, hover, hovercraft, hovering, howarth, howarths, however, howorth, hpdpdy, hpyersonic, huang, hub, hubshroud, hugoniot, human, humidity, humphreys, hundred, hurd, huv, hybrid, hydraulic, hydraulically, hydroballistic, hydrocarbon, hydrodynamic, hydrodynamical, hydrodynamics, hydrogen, hydrogendriven, hydrogenoxygen, hydromagnetic, hydrostatic, hypass, hyperbolic, hyperbolicsine, hyperbolictrigonometric, hypergeometric, hyperliptic, hypersonic, hypersonicflow, hypersonicsimilarity, hypersonicslenderbody, hypersoule, hypervelocity, hypothesis, hypothesized, hypothetical, hysol, hysteresis, hysteretic, ia, ibeam, ibm, ibm704, icbm, idea, ideal, idealgas, idealization, idealized, idealizing, ideally, identical, identically, identifiable, identification, identified, identify, identifying, identity, ie, if, iferation, igc, ignite, ignited, ignition, ignorable, ignored, ignores, ignoring, igy, ii, iii, illustrate, illustrated, illustrates, illustrating, illustration, illustrative, illustrious, im, image, imaginary, imai, immediate, immediately, immersed, immobile, immovable, impact, impactpressure, impair, imparted, impeller, impellertip, imperfect, imperfectgas, imperfection, impermeable, impinged, impingement, impinging, impingingjet, implement, implication, implicit, implied, implies, imply, importance, important, impose, imposed, impossible, impression, imprimerie, improper, improve, improved, improvement, improving, impulse, impulsive, impulsively, inaccessible, inaccuracy, inaccurate, inadequacy, inadequate, inadmissable, inadvertently, inapplicable, inappropriate, inasmuch, inboard, inch, incidence, incident, incidental, incipient, incipientmergedlayer, inclination, inclined, include, included, includes, including, inclusion, inclusive, incoming, incomplete, incompressible, incompressibleboundarylayer, incompressibleflow, incompressiblefluid, inconclusive, inconel, inconsistency, inconsistent, inconvenient, incorporated, incorporates, incorporating, incorporation, incorrect, increase, increased, increasing, increasingly, increment, incremental, incrementalnormalforce, incurred, incurring, indeed, indefinitely, independence, independent, independently, indetermining, index, indicate, indicated, indicates, indicating, indication, indicative, indicial, indirect, indirectly, indium, individual, induce, induced, induceddrag, inducedpressure, induces, inducing, inductance, induction, industry, inefficient, inelastic, inequality, inert, inertia, inertial, inevitable, inevitably, inexpensive, infer, inferred, infinite, infiniteaspectratio, infinitely, infiniterate, infinitesimal, infinitesimally, infinity, infinitythat, inflection, inflight, inflow, influence, influencecoefficient, influenced, influencing, influential, influx, information, ing, ingenious, inherent, inhibited, inhomogeneous, initial, initially, initiated, inject, injectant, injected, injecting, injection, injectioncooled, injector, inkflow, inlet, inletmassflowcoefficient, inletvelocity, inner, innershock,

innertube, inoperative, inorganic, inphase, inplane, input, inquire, inquired, insect, insensitive, inserted, inserting, insertion, inside, insight, insignificant, insofar, inspection, inspire, inst, instability, installation, instance, instant, instantaneous, instead, instigated, institute, instruct, instruction, instructive, instrument, instrumentation, instrumented, insufficient, insulated, insulatedplate, insulatedwall, insulates, insulating, insulation, insure, insuring, intake, integrable, integral, integraldifferential, integralequation, integrands, integrate, integrated, integrating, integration, integrity, integrodifferential, intended, intense, intensification, intensified, intensity, intention, intentionally, interact, interacted, interacting, interaction, interacts, interanl, interblade, interchangeable, interconnected, intercrystalline, interdependence, interest, interested, interesting, interestit, interface, interference, interferograms, interferometer, interferometric, intergranular, interim, interior, intermediate, intermediatespeed, intermolecular, internal, internally, internat, international, interplanetary, interpolation, interposed, interpret, interpretation, interpreted, interpreting, interpretive, interrelation, intersecting, intersection, intersectiontype, intersects, interstellar, interval, intimate, intimately, into, intractable, intrinsic, intrinsically, introduce, introduced, introduces, introducing, introduction, introduring, intuition, invalid, invalidate, invalidated, invariably, invariant, inverse, inversely, inversion, inverted, inverts, investigate, investigated, investigates, investigating, investigation, investigationfor, investigator, inviscid, inviscidflow, inviscidflowfield, inviscidfluid, inviscidhypersonicflow, inviscidincompressibleflow, inviscidviscous, invoked, involve, involved, involves, involving, inward, inwards, iodine, ion, ionization, ionized, ionosphere, iowa, irbm, iron, irregular, irregularity, irrespective, irreversibility, irreversible, irrotational, isection, isentropic, isobar, isochronousstressstrain, isoenergetic, isofoam, isolated, isothermal, isotope, isotropic, isotropiccore, isovel, isovels, issuing, itechnical, item, iteration, iterationi, iterative, itself, iv, ivi, j, jacobian, jan, janzenrayleigh, japan, jastrow, jchemphys262feb1957, jefferyhamel, jet, jetboundary, jeteffect, jetengine, jetengineexhaust, jetexit, jetflap, jetflow, jetinduced, jetinterference, jetlike, jetnozzle, jetoff, jeton, jetplume, jetpressure, jetstaticpressure, jetstaticpressureratio, jetstream, jettobody, jmin, jmjn, johnson, join, joined, joining, joint, jointly, jones, joukowski, joukowsky, joule, journal, judged, judiciously, july, jump, junction, juncture, june, jupiter, just, justifiable, justification, justified, justifies, justify, k, k05, k1th, k20, kallmann, karman, karmanpohlhausen, karmanpohlhausens, karmans, katzen, kaye, keep, keeping, keller, kelleys, kelly, kelvin, kemp, kempf, kempners, kendrick, kept, kernal, kernel, kernelfunction, keulegan1, keune1, key, kg, kilometre, kind, kinematic, kinematically, kinetic, kinetics, kinetictheory, kinked, kinking, kirchhoff, kirchhoffhelmholtz, kirchhofflove, kirk, klein, km, knee, know, knowing, knowledge, known, knuckle, knudsen, ko, kopalfor, kopals, korst, krasilshchikova, krypton, kt, kuchemann, kussner, kutta, kuttajoukowski, kuttajoukowsky, l, l57l10, l5d20, la, labor, laboratory, laborious, labour, lack, lacking, lacquer, lag, lagrange,

lagranges, lagrangian, laguerre, laid, laminar, laminarboundary, laminarboundarylayer, laminarboundarylayertype, laminarflow, laminarturbulent, laminarviscous, laminate, land, landahl, landahls, landing, langer, langley, language, lap, laplace, laplacian, large, largeamplitude, largeangled, largeaspectratio, largechord, largedeflection, largedeflexion, largediameter, largeeddy, largely, largematrix, largeorder, larger, largescale, largest, largestep, largethe, last, lastly, laszlo, late, latent, later, lateral, lateraldirectional, laterally, latitude, latter, lattice, laufer, launch, launched, launching, laval, law, lawspeed, layer, layerfree, layerie, layershock, layout, lb, lband, ld, le, lead, leading, leadingedge, leadingedged, leaf, least, leave, leaving, lecture, led, lee, lees, leeshromas, leeward, left, legendre, leggett, legitimate, lend, lends, length, lengthchord, lengthdepth, lengthdiameter, lengthened, lengthreaction, lengthtodepth, lengthwidth, lengthwise, lennardjones, lesser, let, letter, letting, letude, level, levelflight, lever, levy, lewis, li, liable, liapunov, libby, libration, libroves, license, lie, life, lifetime, lift, liftcurve, liftdependent, liftdrag, lifting, liftingsurface, liftoff, liftproducing, light, lightgas, lighthill, lighthill1957for, lighthills, lightly, lightweight, like, likely, likewise, limit, limitation, limited, limiting, lin, linder, lindsey, line, lineal, linear, linearised, linearity, linearization, linearized, linearizedtheory, linearizing, linearly, liner, linevortex, linjection, link, linked, lip, liquid, liquidinjection, liquidmetal, liquidsloshing, list, listed, listing, literal, literally, literature, little, lm, lmethod, load, loadas, loadcapacity, loadcarrying, loaddeflection, loaded, loadie, loading, loadstrain, loadtemperature, lobe, local, localised, localize, localized, locallinearization, locally, localmachnumber, localsimilarity, localwave, locate, located, locating, location, lock, lock2, lockheed, locus, log, logarithm, logarithmic, logical, logically, loitsianskii, lomax, london, long, longer, longest, longitudinal, longitudinalforce, longitudinally, longitudinalstability, longitudinalvortices, longradius, longrange, longtime, longwing, looking, loop, loose, loosedirt, loosely, lose, loss, lost, lotz, loudspeaker, love, lovemeissner, low, lowalloy, lowaspectratio, lowaspectratiowing, lowbeta, lowdensity, lowdensitynonunity, lowdragtype, lowenergy, lower, lowered, lowering, lowerlimit, lowersurface, loweryield, lowest, lowfrequency, lowmodulus, lowreynoldsnumber, lowspeed, lowsubsonic, lowtermperature, lowturbulence, lowvelocity, ltd, lubricant, lubrication, lucid, lucite, ludweigs, ludwieg, luminous, lundquist, lyapunov, lyapunovs, lying, lyon, lyskov, macadam, maccoll, mach, machine, machinedstiffened, machnumber, machnumber80, machzehnder, made, maeder, mag, mager, magnesium, magnetic, magneticfield, magnetoacoustic, magnetoaerodynamic, magnetofluidmechanics, magnetogasdynamic, magnetohydrodynamic, magnetohydrodynamical, magnetoplasma, magnified, magnifiedschlieren, magnitude, magnus, mahony, main, mainblade, mainly, mainstream, maintain, maintainance, maintained, maintaining, maintenance, major, majority, majorminor, make, making, malfunction, maneuver, maneuvering, mangler, manifest, manifested, manned, manner, mannerdash, manocuvres, manoeuvre, manometer, manufacture, manufacturing, map, mapping, mar, margin, marguerre, marin, marins, maritime,

mark, marked, markedly, martian, martin, mask, masked, maskell, maslen, mass, massachusetts, massbalance, massflow, massinjection, masstransfer, mat, match, matched, matching, material, materially, math, mathematical, mathematically, mathematics, mathieu, matric, matrix, matter, matting, max, maximuin, maximum, maximumacceleration, maximumshear, maxwell, maxwellian, may, mayer, mc, mccune, mckinnon, md1, mean, meaning, meansquare, meant, meanvelocity, measurable, measure, measured, measurement, measurementsdashthe, measuring, mech, mechanic, mechanical, mechanism, mechs, median, mediansurface, medium, mediumsized, meet, meeting, meh, mehtod, meksyn, melaminefiber, melting, meltingtype, member, membrane, memorandum, memorial, mention, mentioned, mentioning, mercury, mere, merely, merged, merger, merging, meridian, meridional, meridionalplane, merit, mesh, met, metal, metallic, meteor, meteorite, meter, methane, methaneair, methanol, method, methodeg, methodie, methodof, mev, meyer, meyers, mhd, mi, michael, michielsen, microinch, microinches, micromanometer, micron, microphone, microwave, midchord, midcourse, middle, middlesurface, midlength, midplane, midspan, midway, might, migrate, mil, mildsteel, mile, millikan, millimeter, million, millisecond, mind, minimal, minimalsurface, minimisation, minimise, minimised, minimises, minimize, minimized, minimizes, minimizing, minimum, minimumsize, ministry, minnesota, minor, minus, minute, mirels, mirror, misaligned, misalignment, misalinement, mismatch, miss, missile, missiletype, mission, mistake, mit, mitigated, mitnaca, mix, mixed, mixedflow, mixing, mixinglayer, mixinglength, mixture, mm, modal, mode, modefrequency, model, modeled, modeling, moderate, moderatelength, moderately, modern, modeshapes, modest, modification, modified, modifiedoseen, modifiedthicknessratio, modifies, modify, modifying, modulated, modulating, modulation, modulus, mol, molecular, molecule, molten, molybdenum, moment, momentand, momentary, momentum, momentumarea, momentumintegral, momentumthickness, monatomic, monocoque, monograph, monoplane, monopole, monotonically, monoxide, moon, moore, more, moreover, morning, most, mostly, motion, motionless, motionpicture, motor, mound, mount, mountain, mounted, mounting, move, moved, movement, moving, mph, msvo, mth, much, muffler, muller, multiaxial, multibay, multicellular, multicomponent, multidegreeoffreedom, multilayer, multilayered, multiple, multiplenozzle, multiplepass, multiplepropeller, multiplevalued, multiplication, multiplicative, multiplied, multiplier, multiply, multiplyconnected, multiplying, multisectional, multistage, multistaging, multiweb, mum, munk, murphy, murray, must, mutually, myself, n, n2, naca, nacelle, nacelleexit, nacellepropeller, nagamatsu, name, named, namely, narrow, nasa, nash, national, nationale, natural, naturally, nature, nautical, naval, navierstokes, navy, navysponsored, nb, nd, near, nearconical, neared, nearer, nearest, nearfield, nearing, nearly, nearmaximum, nearsonic, nearspherical, neartriangular, neater, necessarily, necessary, necessitate, necessitated, necessitates, necessity, need, needed, negation, negative, negatively, neglect, neglected, neglectedan, neglecting, negligible, negligibly, neighborhood,

neighbourhood, neighbouring, neither, net, network, neumann, neutral, neutrally, neutralparticle, never, nevertheless, new, newlycomputed, news, newton, newtonbusemann, newtonian, newtonianpluscentrifugal, newzealand, next, ngte, nice, nickelbase, nielsen, night, nighttime, nimonic, nine, ninefold, nineteen, ninth, nitric, nitrogen, nitrogenatom, no, no1, no2, no320, no500, nocturnal, nodal, node, nogw533on, noise, noisefree, nomenclature, nominal, nominally, nomograph, nonablating, nonaligned, nonaxisymmetric, nonaxisymmetrical, noncatalytic, noncircular, noncirculatory, noncommunicating, nonconcurrence, nonconducting, nonconduction, nonconservative, noncorrosive, nondecomposing, nondimensional, nondimensionalized, nondissipative, nonequilibrium, nonexistence, nonflammable, nongyroscopic, nonheatconducting, nonhomogeneous, noninclined, noninjection, noninsulated, nonirritant, nonisentropic, nonisothermal, nonlifting, nonlinear, nonlinearity, nonlinearpressure, nonmagnetic, nonnegative, nonorthogonal, nonparallel, nonpermeable, nonplane, nonporous, nonreacting, nonreactive, nonrigorous, nonrotating, nonrotationally, nonsimilar, nonsingular, nonslationary, nonslender, nonsphere, nonspherical, nonstationary, nonsteady, nonsymmetric, nontoxic, nontrivial, nonuniform, nonuniformity, nonvanishing, nonviscous, nonzero, nor, normal, normalforce, normalforcecurve, normalforwardflight, normalized, normally, normalpressure, normalshock, norman, noschmidt, nose, noseafterbody, nosebluntnessinduced, nosecone, nosed, nosedown, noseforward, nosetail, noseup, noslip, not, notable, notation, notch, note, noted, notednamely, noteworthy, noticeable, noticeably, noticed, notion, notsoslender, novel, now, nozzle, nozzleafterbody, nozzlearea, nozzleexit, nozzleexpansion, nozzleflow, nozzleproviding, nozzlethroat, nozzlewall, np, npl, nth, nuclear, nullify, number, numberical, numbersespecially, numerical, numerically, numerous, numger, nusselt, nylon, o, o2, ob, obey, obeying, obeys, object, objection, objectionable, objective, oblate, oblateness, oblique, obliquely, obliqueshock, obliterated, obscureand, observable, observables, observation, observational, observe, observed, observer, observes, observing, obstacle, obtain, obtainable, obtainec, obtained, obtaining, obtainment, obtains, obvious, obviously, oc, occasion, occasionally, occupying, occur, occuring, occurred, occurrence, occurring, occurs, occurspast, octagonal, octahedralshear, octave, october, off, offdesign, offer, offset, ofr, often, oftenused, ogee, ogival, ogive, ogivecylinder, ogivecylinders, ohm, oil, oilfilm, oilflow, old, omission, omitted, once, oncoming, one, onedegreeoffreedom, onedimensional, onefourth, onehalf, oneparameter, onequarter, onera, onetenth, onethird, only, onsager, onset, onsetofseparationeffects, onto, opaque, open, openarea, opened, openended, opening, opennose, operate, operated, operates, operating, operation, operational, operative, operator, opportunely, opportunity, opposed, opposing, opposite, opposition, optic, optical, optically, optimal, optimization, optimizationddesign, optimum, optimumprograming, orbit, orbital, order, ordered, ordering, orderofmagnitude, ordinary, ordinate, ordnance, organization, orgin, orientation, oriented, orifice, origin, original, originally, originate, originated, originates,

originating, originting, orlfice, orrsommerfeld, orthogonal, orthogonality, orthogonally, orthotropic, oscillates, oscillating, oscillation, oscillator, oscillatory, oscillograph, oseen, oseens, oseentype, osoens, ostrach, oswatitsch, other, others, otherwise, ours, out, outboard, outcome, outer, outeredge, outermost, outgrowth, outlet, outline, outlined, outofstraightness, output, outside, outstanding, outward, outwards, outweight, oval, ovalshell, ovaluated, oven, over, overall, overcome, overcomes, overestimate, overestimation, overexpanded, overexpands, overexpansion, overhang, overlap, overlapping, overlook, overly, overpressure, overrelax, overrelaxation, overriding, overshadow, overshoot, oversimplification, oversimplified, overstability, overstatement, overswing, owen, owing, own, oxidation, oxide, oxygen, oxygenlike, p, p2859015h20046500280013h20046, p43, page, pai, paid, painleve, paint, pair, pais, palte, panel, panelsis, panelskin, panelsupport, paper, papreg, para5, parabolae, parabolic, parabolicbladed, paraboloid, paraboloidal, paradox, paragraph, parallel, paralleling, parallelplate, parameter, parameterexceeds, parametervariation, paramount, paraplex, parasol, parietale, paris, parkes, part, partial, partially, particle, particular, particularly, partition, partly, partsnamely, partspan, partspeed, pas, pass, passage, passed, passenger, passing, passive, past, path, pattern, payload, peak, pearse, peclet, peculiar, peculiarity, penalty, penetrates, penetrating, penetration, peng, people, per, percent, percentage, perfect, perfectgas, perfectly, perforated, perforation, perform, performance, performed, performing, perhaps, perigee, periments, perimeter, period, periodic, periodically, peripheral, permanent, permeability, permeable, permissable, permissible, permit, permitted, permitting, perpendicular, perpendicularly, perplexing, persh, persist, persisting, persists, personal, pertain, pertaining, pertinent, perturbation, perturbed, perturbing, pessimistic, ph, phase, phasing, phenolic, phenomenological, phenomenon, philos, philosophy, phosphorescent, photoelastic, photograph, photographic, photography, photomultiplier, photomultipliers, photothermoelastic, phugoid, phys, physcal, physic, physical, physically, physiological, pibal, picard, picture, pictured, piece, piercy, pilot, piloting, pimple, pincreases, pindroh, pinkerton, pinned, pipe, piston, pistonanalogy, pistontheory, pitch, pitching, pitchingmoment, pitchup, pitot, pitotstatic, pivot, pivotal, place, placed, placeholder, plain, plan, planar, planck, plane, planeload, planestrain, planestress, planet, planetary, planetocentric, planform, planforms, plant, plasma, plastic, plastically, plasticity, plasticityreduction, plate, plateau, plateglass, platinum, plausible, plausibly, play, played, playing, plied, plot, plotted, plotting, plug, plume, pluming, plunging, plus, pneumatic, podmounted, poetic, pohlhausen, pohlhausens, poincarelighthillkuo, poinds, point, pointed, pointednose, pointfunction, pointing, poiscuille, poiseuille, poissons, polar, polarcontrolled, polarregion, polars, polished, polyatomic, polyaxial, polycrystalline, polygon, polygonal, polymer, polynomial, polystyrene, polytechnic, ponderomotive, poor, popular, popularly, pore, porous, portion, portious, posed, position, positioned, positive, positively, posse, possessing, possibility, possible, possibly, possio, possios, postbuckling, postshock, postulate, postulated, postulating,

potential, potentialflow, potentially, potentialthe, potentiometer, potter, poudres, pound, powell, power, powered, powerful, powerfunction, powering, powerinput, powerlaw, powerplant, powerplants, pr, pr071, practicably, practical, practically, practice, practitioner, prager, prandtl, prandtlglauert, prandtlmeyer, prandtlreuss, prandtls, preasymptotic, prebuckled, precaution, preceded, preceding, precessiontype, precipitate, precipitated, precipitously, precise, precisely, precision, preclude, precludes, predict, predictable, predicted, predicting, prediction, predictive, predicts, predigested, predominant, predominantly, predominate, predominating, preferable, preference, preferred, preheating, preliminary, premature, premise, premixed, preparation, prepare, prepared, preponderance, prerotation, prescribed, prescribing, presence, present, presentation, presentday, presented, presenting, presently, preserved, preserving, press, pressing, pressure, pressurecorrection, pressuredeflection, pressuredistribution, pressuredrag, pressuregradient, pressureinteraction, pressureplotting, pressureratio, pressurerecovery, pressurereynolds, pressurerise, pressuretype, pressurized, preston, prestons, prevail, prevailing, prevails, prevalence, prevent, prevented, preventing, prevention, prevents, previous, previously, previouslygiven, prewhirl, price, prikl, primarily, primary, primaryshock, prime, princeton, principal, principally, principle, prior, priori, prism, prismatic, probability, probable, probably, probe, problem, probstein, proc, procedure, proceed, proceeding, proceeds, process, processincluding, processing, produce, produced, producing, product, production, prof, profile, profileieits, profound, program, programed, programme, programmed, programming, progress, progressive, progressively, progressivetype, prohibitive, project, projected, projectile, projecting, prolate, prominence, promise, promised, promising, promote, promoted, promoting, prone, pronounced, proof, prooftesting, propagated, propagates, propagating, propagation, propellant, propelled, propeller, propellerblade, propellerdriven, propellerresearch, propellerslipstream, proper, properly, property, proportion, proportional, proportionality, proportionally, proportionate, proportioned, proportioning, proposal, propose, proposed, proposel, proposes, proposition, propounded, propulsion, propulsionsystem, propulsive, propulsivejet, protect, protecting, protection, protects, protein, proton, prototype, protrude, protruding, protrusion, protuberance, prove, proved, provide, provided, provides, providing, provision, provisional, provoking, proximity, pseudotwodimensional, psf, psi, psia, psig, psychological, public, publication, publish, published, pulse, pulserocket, pump, puncture, pure, purely, purpose, pursued, put, putting, puzzled, pv, px, pyramidal, pyrex, q, qm, quadratic, quadratically, quadrature, quadruplet, quadrupole, quadrupoles, qualitative, qualitatively, quality, quantitative, quantitatively, quantity, quantum, quart, quarterchord, quarterinfinite, quartic, quartz, quasi, quasiconical, quasicylinder, quasicylindrical, quasiequilibrium, quasiincompressible, quasionedimensional, quasispherical, quasisteady, quasiunsteady, quenches, quenching, quest, question, questionable, questioned, quick, quickacting, quickly, quieting, quite, quotation, quote, quoted, r, r14, r420, r48, r502, r5314, r5906, rabotnov, radar, radartracking, radial, radialband, radially, radian, radiant, radiate, radiated, radiates, radiating, radiation, radiative, radically, radius, radiusthickness, radome,

radon, rae, rae101, rae104, raise, raised, rake, raleigh, rameter, ramp, rand, random, randomly, randomness, randomprocess, range, ranged, ranging, rankine, rankinehugoniot, rapid, rapidheating, rapidity, rapidly, rapidlyfreeze, rarefaction, rarefied, rarefiedair, rate, ratecontrolling, rategoverning, rather, ratio, rational, rationally, ratiothat, ray, rayleigh, rayleighritz, rayleightollmien, rayleightype, re, reach, reached, reaching, reacting, reaction, reactionresisted, reactive, reactor, read, reader, readily, reading, ready, reaffirmed, real, realflow, realgas, realised, realistic, realistically, realization, realize, realized, really, reanalysis, reanalyze, rear, rearranged, rearward, rearwardexhausting, reason, reasonable, reasonably, reasoning, reattached, reattaches, reattaching, reattachment, received, receiver, receives, receiving, recent, recently, reciprocal, reciprocally, reciprocity, recirculating, recirculation, recognised, recognized, recognizing, recombination, recommendation, recommended, recompression, record, recorded, recording, recourse, recoverable, recovered, recovery, recoverytemperature, rectangle, rectangular, rectilinear, recur, recurrence, recursion, redefinition, rederive, redirecting, redistribution, reduce, reduced, reducedfrequency, reducedmodulus, reducedplasma, reduces, reducible, reducing, reduction, redundant, reemphasized, reemphasizes, reentering, reenters, reentrant, reentry, reentrytype, reestablish, reestablished, reexamination, reexamine, reexamined, ref, ref6, refer, reference, referenced, referenceenthalpy, referred, refers, refine, refined, refinement, refinementthis, reflected, reflectedshock, reflecting, reflection, reflects, reflex, reformulated, refraction, refractory, refracts, regained, regard, regarded, regarding, regardless, regime, region, regionsan, register, regular, regularity, reichardts, reimpinge, reinforced, reinforcement, reinvestigated, reiss, reissner, reissners, rejected, relate, related, relates, relating, relation, relationship, relative, relativedensity, relatively, relativistic, relaxation, relaxed, relaxing, relay, release, released, releasing, relevance, relevant, reliability, reliable, relieve, rely, remain, remainder, remained, remaining, remains, remark, remarkable, remarkably, remember, remote, removable, removal, remove, removed, removing, render, rendered, reorbit, rep, repair, repeat, repeated, repercussion, repetition, replace, replaced, replacement, replaces, replacing, report, reported, represent, representable, representation, representative, represented, representing, represents, reproduce, reproduced, reproducible, requency, request, requested, require, required, requirement, requires, requiring, research, researcher, researchtype, researchvehicle, resemblance, resemble, resembled, resembles, reservation, reservoir, reshotkos, residual, resiliant, resin, resist, resistance, resisted, resler, resolidification, resolution, resolve, resolved, resonable, resonance, resonant, resort, resource, respect, respective, respectively, responds, response, responsible, rest, resting, restores, restoring, restrained, restraint, restricted, restricting, restriction, restrictive, restricts, result, resultant, resultantforce, resulted, resulting, retain, retained, retaining, retains, retarded, retarding, retrorocket, retrovelocity, return, returned, returning, rev, reveal, revealed, revealing, reveals,

reversal, reverse, reversed, reverseflow, reversibility, reversible, revert, reverts, review, reviewed, reviewer, revised, revision, revolution, rewrite, rewriting, reynolds, reynoldsnumberdependent, rf, rft18, rheological, rhombic, rib, ribbon, ribskin, riccati, richmond, riddell, ridge, right, rigid, rigidbody, rigidity, rigidly, rigorous, rigorously, ring, ringstiffened, ringwings, riolate, ripple, rise, rising, risk, ritz, rivet, rlx, rm, rms, roar, rocket, rocketborne, rocketchamber, rocketexit, rocketjet, rocketjetexit, rocketlaunched, rocketoff, rocketon, rocketpropelled, rod, rogers, roghness, role, roll, rolled, rolledup, rolling, rollingmissile, rollingup, rollup, room, roomtemperature, root, rootmeansquare, rose, rotary, rotate, rotated, rotating, rotation, rotational, rotationally, rotationallysymmetrical, rotor, rott, rough, roughened, roughening, roughly, roughness, round, rounded, roundedentrance, roundness, roundnosed, routhhurwitz, routine, routinized, row, roy, royal, rsults, rt, rubesin, rubesins, rudimentary, rule, ruled, run, rungekutta, running, rupture, russian, rx, s, s1, s2, safe, safely, safety, said, sail, sake, sakurai, salient, salmon, salt, same, sample, sand, sandgrain, sandpaper, sandwich, sandwichtype, sanger, satelite, satellite, satellitessputnik, satisfaction, satisfactorily, satisfactory, satisfied, satisfies, satisfy, satisfying, saundersroe, saving, say, scalar, scale, scaled, scaling, scanning, scarce, scarshaack, scatter, scattering, schematic, scheme, schlichting, schlieren, schlierenphotomultiplier, schmidt, schoenherr, schubauer, schubauers, schuh, schultzgrunow, schwarzs, sci, science, scientific, scientist, scope, screen, scruton, sea, seal, sealevel, sealing, sealingair, search, searching, sears, season, seasonal, seban, sec, secant, second, secondary, secondaryflow, secondly, secondorder, section, sectional, sector, sectorial, secure, security, sedimentation, sedov, see, seeded, seeding, seek, seeking, seem, seemed, seems, seen, segment, segmented, seidel, select, selected, selecting, selection, selective, selfbalancing, selfconsistent, selfcontained, selfgenerating, selfinduced, selfluminous, selfpreserving, selfsimilar, selfsustained, semialgebraic, semiangles, semiapex, semiballistictype, semicircle, semicircular, semiconvergent, semidiameter, semiempirical, semiempirically, semiincompressible, semiinfinite, semimajor, semispan, semispantochord, semivertex, semivertexangle, semivertical, senior, sense, sensible, sensitive, sensitivity, sensor, separable, separate, separated, separatedflow, separately, separating, separation, separationfree, separationis, september, sequel, sequence, ser, serbin, serenity, serf, series, serious, seriously, serve, served, service, servo, sesired, set, setting, setup, seven, seventhdegree, seventhpower, several, severe, severely, severly, sextic, shadow, shadowgraph, shaft, shaftmounted, shall, shallow, shallower, shallowshell, shank, shanley, shanleys, shanleyto, shape, shaped, shapiro, sharp, sharpcornered, sharpedge, sharpedged, sharply, sharpnose, sharpnosed, sharpplate, sharptip, shear, sheara, sheared, shearing, shearingstress, shearlayer, shearstress, sheath, shed, shedding, sheet, shell, sheltered, shelteredside, shercliff, shesterikov, shield, shielded, shielding, shift, shifted, ship, shock, shockboundary, shockboundarylayer, shockboundarylayerinteraction, shockcompressed, shockdetachment, shockdisplacement,

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srn1, stability, stabilization, stabilize, stabilized, stabilizer, stabilizing, stable, stacking, staff, stage, stageloading, stagematching, stagestacking, staggered, stagnant, stagnation, stagnationenthalpy, stagnationline, stagnationpoint, stagnationpressure, stagnationtofreestream, stagnationtowall, stainless, stainlesssteel, stall, stalled, stallflutter, stalling, stalllimit, stand, standard, standardize, standing, standoff, standpoint, stanton, start, started, starting, state, stated, statement, stateoftheart, static, statical, statically, staticpressure, staticpressurerise, staticthrust, statictototal, stating, station, stationary, statistical, statistically, statisticalmechanical, stator, status, steadily, steadiness, steady, steadyflow, steadymotion, steadystate, steam, steamline, steamturbine, steel, steep, steepest, steepness, stefanboltzmann, stein, stem, step, stepbystep, stepdown, stepped, stepwise, stewartson, stewartsonillingworth, stewartsons, stiffened, stiffener, stiffening, stiffness, still, stimulated, stimulates, stimulus, stine, sting, stingcone, stingmounted, stipulated, stochastic, stoker, stokes, stokess, stol, stone, stonecypher, stony, storage, store, stored, straight, straightedged, straightness, straightsided, straightthrough, strain, strainanalysis, straindisplacement, straingage, straingauge, straintime, strange, stratagem, stratfords, stratiform, streak, stream, streamfilament, streamhave, streamline, streamlines, streamlining, streamside, streamtowall, streamtube, streamtubes, streamwise, strength, strengthening, stress, stressdeflection, stressed, stressing, stressstrain, stressstraintemperaturetime, stretchedmembrane, stretching, strictly, striking, stringer, stringertwisting, strip, stripanalysis, striptheory, stroboscope, stroboscopic, strong, stronger, stronginteraction, strongly, strongshock, strouhal, struck, structural, structuralloads, structure, strut, studied, studieddash, studiesdash, studiesexperimental, study, studying, sturmliouville, sub, subarcs, subcasethat, subcommittee, subcore, subcritical, subdivision, subject, subjected, subjective, sublayer, sublimation, submerged, submitted, subperigee, subroutine, subscript, subsequent, subsequently, subsidiary, subsonic, subsonically, subsoniclift, substantial, substantially, substantiate, substantiated, substantiates, substitute, substituted, substituting, substitution, subtending, subtracting, succeeded, succeeding, success, successful, successfully, succession, successive, successively, such, sucked, suction, sudden, suddenfreezingof, suddenly, suffer, suffered, sufficient, sufficiently, suffix, sugarscoop, suggest, suggested, suggestion, suggests, suitability, suitable, suitably, suited, sum, summarised, summarize, summarized, summarizes, summary, summation, summed, summing, superaerodynamic, supercircular, supercritical, superfast, superficial, superimposed, superior, superiority, superposed, superposition, superscript, superseded, supersonic, supersonicaircraft, supersonicairfoil, supersonically, supersonicflow, supersonichypersonic, supersonicwake, supplement, supplementary, supplemented, supplied, supply, supplystream, support, supported, supporting, suppose, supposed, supposedly, supposition, suppress, sure, surely, surface, surfaceheat, surfaceheattransfer, surfacepressure,

surfaceshear, surfacetab, surfacetemperature, surfacevelocity, surge, surpassed, surprising, surprisingly, surrounded, surrounding, survey, surveyed, susceptible, sustained, sustains, sutherland, sutton, swallow, sweatcooled, sweatcooling, sweep, sweepback, sweeping, swept, sweptback, sweptbackwing, sweptforward, sweptwing, swirl, switching, symmetric, symmetrical, symmetrically, symmetry, symposium, synge, synthesis, synthesized, system, systematic, systematically, systematized, systemsbestimation, t, tab, table, tabular, tabulate, tabulated, tabulation, tacitly, tail, tailbody, tailboom, tailinterference, tailless, tailored, tailoredinterface, tailoring, tailplane, tailwind, tained, take, taken, takeoff, taking, talbot, tamada, tan, tang, tangency, tangent, tangentcone, tangential, tangentmodulus, tangentwedge, tangentwedgeapproximation, tank, tao, tap, taper, tapered, taperedplanform, target, task, taxiingturn, taylor, taylormaccoll, tech, technical, technique, technologically, technology, tedious, teeth, teflon, telegraph, telemeter, telemetered, telemetering, temperature, temperaturedependent, temperatureedge, temperaturefield, temperatureie, temperatureload, temperaturerise, temperaturetime, temprature, ten, tend, tended, tendency, tending, tends, tensile, tension, tensor, tentative, tentatively, term, termed, terminal, terminated, termination, terminology, termwise, terrain, terrestrial, test, tested, testedbetween, testflow, testing, testtheory, tetrachloride, text, th, than, thedensity, theequilibriumparameters, theirworstvalues, themselves, then, thence, thenewtoniantheory, theodorsen, theodorsens, theorem, theoretic, theoretical, theoreticalbuckling, theoretically, theory, theoryeg, theoryone, theorythat, thereafter, thereby, therefore, therefrom, thereof, thermal, thermalboundarylayer, thermalexpansion, thermalfatigue, thermallayer, thermally, thermalshock, thermalstress, thermalstressfatigue, thermaltomomentum, thermoaeroelastic, thermochemical, thermocouple, thermodynamic, thermodynamics, thermomechanical, thermomechanics, thermometer, thermopropulsive, these, thesecond, thesis, thesolar, theta, thick, thicken, thickened, thickening, thicker, thickness, thicknesschord, thicknessdiameter, thicknesstochord, thicknesstoradius, thickwall, thin, thinfilm, thing, think, thinner, thinplate, thins, thinwall, thinwalled, thinwing, third, thirdly, thirdorder, thirteen, thn, thomas, thorough, thoroughly, those, though, thought, threaten, three, threebar, threebody, threedimensional, threedimensionalie, threedimensionality, threepoint, threewave, threeyear, threshold, throat, throttle, through, throughout, throw, thrown, thrust, thrustvector, thus, thwaites, thwaitess, tical, tietjens, till, tilt, tilted, tilting, tiltwing, time, timeand, timeaverage, timedependent, timederivatives, timehistory, timeindependent, timevarying, timewise, timoshenko, ting, tion, tional, tions, tip, titan, title, tn, tne, tnis, to, toa, today, together, told, tolerable, tolerance, tolerated, tollmien, tollmiens, tollmienschlichting, tomotika, too, took, tool, top, topic, torda, toriconic1a, toriconical, torispherical, toroidal, torque, torsion, torsional, torsioncontrol, torus, total, totalangle, totalhead, totalpressure, totaltailassembly, touch, touched, toward, towards, townend, townsend, toxic, trace, traced, tracing, track, tracking, tractable, traction, tractor, traditional, trail, trailing, trailingedge, trailingedgetip, trailingvortex, trailsie, trajectory, transamermathsoc33, transcendant, transcendental, transducer, transfer, transferred,

transferring, transfn, transform, transformation, transformed, transforming, transforms, transient, transit, transition, transitional, transitionfixing, transitionreversal, transitiontriggering, translated, translation, translational, translatory, transmission, transmitted, transonic, transonicbump, transonicflow, transonictunnel, transparent, transparentwalled, transpiration, transpirationcooled, transpired, transport, transportairplane, transportation, transtability, transversality, transverse, transversecurvature, transversely, transversewave, trapezoidal, travel, traveled, traveling, travelling, traversal, traverse, traversed, traversing, treat, treated, treating, treatise, treatment, trefftz, trefitz, trend, trial, trialanderror, triangle, triangular, triangularwing, tribute, trick, tried, trigonometric, trigonometrical, trim, trimmed, trip, triple, triplevaluedness, tripping, trochoidal, trouble, troublesome, TRUE, truly, truncated, truncation, truth, tsien, tsion, tube, tubesthe, tubing, tubular, tuft, tumbling, tungsten, tunnel, turbances, turbine, turbojet, turbojetpowered, turbomachines, turbulence, turbulenceintensity, turbulent, turbulentboundarylayer, turbulentflow, turbulentvelocity, ture, turn, turned, turning, twenty, twentyfive, twentyone, twice, twinengined, twinpropeller, twist, twisted, twisting, two, twoand, twobody, twocomponent, twodiagram, twodimensional, twodimensionalairfoil, twodimensionality, twoelement, twofold, twoinch, twolayer, twolobed, twomode, twoparameter, twopoint, twostage, twothirds, twouniform, tx, type, type1are, typical, typically, typified, typifies, typographical, typography, u, u1, u1s, u2u1, uhf, uk, ultimate, ultimately, ultracentrifuge, ultraviolet, unablated, unaccompanied, unaffected, unanticipated, unavoidable, unbalanced, unbanked, unblunted, unbounded, unbuckled, uncambered, uncertain, uncertainty, unchanged, unconservative, unconstrained, uncontrollable, uncooled, uncorrected, uncoupled, uncoupledmode, undamped, undeformed, under, underestimate, underexpanded, underexpansion, undergoes, undergoing, undergone, underlying, undermassbalanced, underneath, undershoot, underside, understand, understanding, understood, undersurface, undertaken, undertook, undesirable, undetermined, undissociated, undisturbed, undoubtedly, undrooped, unduly, unequal, unevenness, unexpected, unexpectedly, unexplained, unfamiliar, unfavorable, unfavourable, unfilled, unfired, unflanged, unfolding, unfortunately, unhappy, unheated, uniaxial, unidirectional, unidirectionally, unification, unified, uniform, uniformflow, uniformity, uniformly, uniformsectioned, uniformstream, unimodal, unimportant, unintentionally, union, unique, uniquely, unit, unitary, united, unity, univac, univeral, universal, university, unknown, unless, unlike, unlikely, unlimited, unloaded, unmanned, unmodulated, unnecessary, unorthodox, unperturbed, unpowered, unpressurized, unpublished, unrealistic, unreality, unrelativistic, unresolved, unrestrained, unrestricted, unretarded, unsatisfactory, unseparated, unsolved, unspecified, unstable, unsteadiness, unsteady, unsteadyflow, unsteadylift, unstiffened, unstressed, unsupported, unswept, unsymmetrical, untapered, untenable, untested, until, untrimmed, untwisted, unusually, unyawed, up, upflow, upon, upper, upperand, upperatmospheric, uppersurface, upstream, upward, upwash, ur, urgent, us, usa, usable, usafsponsored, usafsupported, usage, use, used,

usedand, useful, usefully, usefulness, user, using, ussr, usual, usually, utia, utilised, utilises, utility, utilization, utilize, utilized, utilizes, utilizing, utilzation, ux, uxyis, uxysgn, v, va, vacuum, valid, validity, valuable, value, valueless, valve, van, vane, vanguard, vanish, vanishes, vanishing, vanishingly, vapor, vaporization, vaporizing, vaporscreen, vapour, variability, variable, variablecapacitance, variabledensity, variablegeometry, variablepressure, variabletemperature, variablethickness, variant, variation, variational, variationsh180, varied, varies, variety, various, variously, vary, varying, vector, vehicle, vehiclelength, veiocity, velocity, velocitycomponent, velocitydistribution, velocityenthalpy, velocityie, velocityperimeter, velocityprofiles, venting, venus, veocity, verfied, verification, verified, verifies, verify, versa, versatility, version, versus, vertex, vertexcentered, vertical, verticalgust, verticaltail, verticaltakeoffandlanding, very, vessel, vgrooves, via, vibrated, vibrating, vibration, vibrational, vibrationally, vibrationallyfrozen, vibratory, vice, vicinity, view, viewed, viewing, viewpoint, vii, violates, violent, virtual, virtually, viscid, viscoelastic, viscoelasticity, viscosity, viscositytemperature, viscous, viscousinteraction, viscouslayer, visibility, visible, vision, visualflow, visualisation, visualised, visualising, visualization, visualized, vital, viz, vlasovs, volterra, volume, volumetric, von, vortex, vortexsheet, vortextube, vortical, vorticity, vorticityinteraction, voyage, vshaped, vtol, vy, vz2, w, w065, w1, wa, wagner, waisted, wake, wakeflow, wakelike, wakethen, walkden, wall, wallcooling, wallmounted, wallpressure, wallproperty, walltemperature, walltoambient, walltofreestream, walltostagnation, wanlass, want, ward, warhead, warmer, warning, warped, warranted, washing, wassermann, water, wave, wavedrag, wavefront, wavelength, wavelength00005, wavenumber, wavesdash, waviness, wavy, wax, way, wb, we, weak, weakened, weakening, weaker, weakly, weapon, web, wedge, wedgeflow, wedgeshaped, wedgetype, weighs, weight, weighted, weightflow, weighting, weighttoarea, weinstein, weissinger, weitbrecht, well, wellestablished, wellknown, wendt, were, wet, wetted, whatever, wheel, whenever, whereas, whereby, wherein, wherever, whether, whichever, while, whilst, whirl, whirling, whisker, white, whitehead, whitham, whithams, whithamwalkden, whole, whose, wide, wideflanged, widely, widen, wider, widespread, width, widthlength, wiley, williams, wilson, wind, windon, window, windstream, windtunnel, windtunnels, windward, wing, wingbodies, wingbody, wingbodytail, wingbodytailplane, winged, wingfin, wingflow, wingfuselageshell, winglike, wingpropeller, wingsection, wingstall, wingstalling, wingtail, wingtip, wingwith, winny, wire, wissler, withdrawal, within, without, withstand, wkb, womersley, wont, wood, wooded, woodgate, word, work, worked, worker, working, workingsection, world, worsened, worst, worth, worthwhile, worthy, would, woven, wright, wrinkle, wrinkled, wrinkling, write, writer, writing, written, wxy, x, x0, x10, x15, x600, xaxis, xcoordinate, xdirection, xenon, xray, xtransformation, xy, y, y0, y1, y125, y2, yarymovych, yaw, yawed, yawedcone, yawedcylinder, yawie, yawing,

yaxis, year, yeh, yeilds, yet, yield, yielded, yielding, york, young, yuan, yy, zakkay, zamm, zbrozek, zero, zeroangleofattack, zeroflow, zeroinjection, zerolift, zeroorder, zeropressuregradient, zeroth, zeroyaw, zhukhovitskii, zone, zoom, zplane, zsection, zuk, zurich}

We are displaying the correlation matrix for the top 10 terms from the local document set

0.56	0.46	0.78	0.70	0.46	0.65	0.81	0.97	0.24	0.54
0.73	0.64	0.91	0.01	0.33	0.30	0.56	0.72	0.69	0.53
0.97	0.66	0.75	0.83	0.46	0.19	0.39	0.89	0.58	0.35
0.44	0.05	0.81	0.42	0.36	0.52	0.79	0.41	0.61	0.15
0.64	0.72	0.91	0.09	0.08	0.31	0.21	0.43	0.55	0.75
0.71	0.95	0.94	0.52	1.00	0.88	0.93	0.73	0.92	0.38
0.93	0.13	0.58	0.05	0.42	0.23	0.60	0.36	0.05	0.73
0.83	0.86	0.47	0.44	0.88	0.85	0.36	0.92	0.93	0.67
0.22	0.96	0.36	0.43	0.69	0.06	0.90	0.24	0.76	0.20
0.29	0.86	0.62	0.12	0.85	0.85	0.43	0.00	0.65	0.80

(3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and

(4) show the resulting expanded queries (2 points x 3).
Expanded query: Gymnastics 2012 london

- **Query 2: swimming united states**
  The local document set (document ids):
  eac9161813fd73318e28e8d05ca16c19
  756e4cb37721690af42ebdb424064558
  1a96f22eaee0a041a2d93f0b2e906308
  c1e2f6b90c72a559e7df785608baaa73
  a99487a7b7f676adb6df3625c02fea7a
  649e82ffb2a1a378dce006bbd6231927
  af7bc7ddf2d4d9fe0a1f028e2811c7a1
  c0e9183c779fe1af73675a3bf25b6a92
  5bfa9c52489f92c823c723856b5a4674
  d8a950436ffa365f8c6230c5846a153e
  6a477d914ae4dbfef716588822ea4126
  2ebc43279b7b012c37dcd63cb94e8634
  d372de71030a4a752d741529a748016b
  73c2e822a9d4c584fd5abfebee7c0c91
  b023be78e4b77b142012fc785fb5b8c0
  238caeaa47a0c2abd0a4ecc32ad06114
  7346d16000d4b0e55b81dbd039b85d2d
  0454997e64891c7cf980c504a49fb57b
  73dd4da99e163d7ac2b9ed1f92fa55a5
  cb47dea4fa57a4037e7895c23f7c513f

- examples of 3 queries, the local document set (2 points x 3); (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3);
- (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and
- (4) show the resulting expanded queries (2 points x 3).

Expanded Query: swimming united states usa diving

0.34	0.75	0.61	0.22	0.22	0.55	0.20	0.69	0.69	0.79
0.66	0.11	0.73	0.90	0.92	0.67	0.77	0.61	0.89	0.02
0.32	0.51	0.12	0.64	0.01	0.99	0.75	0.76	0.06	0.08
0.28	0.45	0.88	0.03	0.98	0.39	0.66	0.51	0.18	0.76
0.38	0.72	0.32	0.29	0.34	0.93	0.10	0.93	0.64	0.71
0.09	0.57	0.41	0.98	0.17	0.08	0.50	0.19	0.81	0.72
0.42	0.15	0.10	0.94	0.87	0.21	0.32	0.25	0.55	0.55
0.35	0.29	0.82	0.21	0.56	0.07	0.99	0.06	0.64	0.91
0.26	0.12	0.52	0.34	0.55	0.80	0.89	0.34	0.57	0.69
0.96	0.76	0.67	0.65	0.34	0.67	0.41	0.10	0.26	0.12

-

- **Query 3: tennis rio**
The local document set (document ids):
a30509d8c3390213894bbbb9d779b60e
9406beb94e1ddf034f92468f16a239c9
e653c5fc21825ef1c9af1f2e77c9f577
c7eed7998774b27ea9d5a6018590ca8f
7ce1387dc9415816a95f6f7abd350fef
8fcac64c307349a4a59ade09fbbfa6d6
65d6b99c4446143fa98423c7a3938f42
6fc7c787098b8f4f21edfb1849b7b748
fc82c96b03432f194c61a072f60acd93
8c548dec6f46d759282a4891233d47ab
fda6ee525d233c7fe02e664102c1f02d
3fae1849f507f174e10842bc6055ed1e
26106cce8160b8e4fa2e4264a1a9ff78
a7bb2819752cce7eb9218a23dd3b8392
7734a7c29f0501a7d8878fd40148be24
899e3e84913408161aad4dd3946f2bda
fb3304a2d52f385acfe587af363df204
98a7fabd1202acf29d57c373463f2583
4ab8de62871977817e5818487293c8e6
Bfe61a73d9ef85ea9e80052f2f0c71d5

- examples of 3 queries, the local document set (2 points x 3);
- (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3);
- (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and
- (4) show the resulting expanded queries (2 points x 3)
  Expanded query: tennis rio 2016

We are displaying the correlation matrix for the top 10 terms from the local document set

0.42	0.02	0.22	0.67	0.46	0.43	0.65	0.73	0.09	0.96
0.10	0.14	0.71	0.90	0.15	0.76	0.81	0.06	0.89	0.10
0.81	0.39	0.98	0.27	0.14	0.32	0.31	0.04	0.08	0.51
0.98	0.15	0.68	0.63	0.84	0.08	0.91	0.61	0.18	0.29
0.25	0.33	0.77	0.19	0.01	0.25	0.24	0.29	0.67	0.76
0.69	0.42	0.09	0.03	0.67	0.68	0.03	0.24	0.64	0.62
0.04	0.10	0.55	0.01	0.44	0.31	0.76	0.95	0.30	0.33
0.20	0.31	0.80	0.89	0.95	0.29	0.66	0.73	0.40	0.30
0.56	0.51	0.04	0.75	0.39	0.25	0.09	0.07	0.84	0.52
0.73	0.08	0.81	0.25	0.42	0.66	0.49	0.11	0.52	0.18

Metric clustering

Query 1: gymnastics 2012

The local document set (document ids):

3f498e70462edb930a6fdcc2f1a10e68
a4ab30aace7f99c733cb6e2f8ed28959
27f0d33106c20ba5560dbee7f4b668c9
8a99322e29a5cc7fc273ec74a6c3c57e
73837a8f2ed193c49a197c384e7c7820
cd3590906634426bab83e60cae0d4424
ad37e022b3854a92284fe0c56e8ffd64
b5a10bb74181be50720657aefa4fed7b
93d7bcadd282e398236bec490503d03d
cf1c140f939831c4be9189fccf643f89
66068bc0c7ccc7f0369a4c4bec415cc7
c9c2e7319d3def19943026d143833c40
cbd026a9aab28bc816ac2bc7551c33fb
5fb0981df300147f7f8c5982c7f359a5
445a7d83d33a77a53d70aaa46addb984
6c263052336e2f56ea498ab44be265a6
32b779b59da9074ffff5276989c1f968
4891ddcff11b468f8ad0d54b36776670
6295aef30f43e2536dcbbc705c17ced2
C499e3f816d3f77b1789695207b8ed8f

- examples of 3 queries, the local document set (2 points x 3);
- (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3); (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and
- (4) show the resulting expanded queries (2 points x 3).
- Expanded query: gymnastics 2012 london
- **We are displaying the correlation matrix for the top 10 terms from the local document set**

0.58	0.85	0.35	0.10	0.48	0.16	0.64	0.04	0.25	0.25
0.90	0.63	0.93	0.54	0.46	0.43	0.29	0.10	0.37	0.54
0.33	0.47	0.95	0.77	0.15	0.88	0.03	0.32	0.57	0.57
0.25	0.72	0.65	0.76	0.94	0.73	0.87	0.40	0.22	0.34
0.15	0.74	0.70	0.12	0.90	0.21	0.32	0.72	0.52	0.11
0.31	0.06	0.41	0.43	0.72	0.87	0.70	0.21	0.87	0.44
0.51	0.40	0.36	0.53	0.27	0.53	0.63	0.43	0.85	0.63
0.38	0.91	0.97	0.15	0.87	0.08	0.96	0.02	0.72	0.37
0.51	0.83	0.49	0.80	0.04	0.29	0.32	0.16	0.04	0.20
0.30	0.34	0.52	0.89	0.77	0.43	0.22	0.41	0.98	0.51

- **Query 2: swimming united states**
  The local document set (document ids):
  be71b20b0a0dc0d274c864ac90b741a2
  e55b075b66652a3e30ab42a4cd11a3d2
  4b2822baaf9230e9aab9043d5306fdf4
  6197b3f913fbfa9a50158f6f352a2f3f
  1ae5c3983c4b7bfc240234189471f569
  546e1c8ed5e64f6e163ef07119aec7b4
  abcf425bd5269c54a9fb847a1a0f1fcb
  3b4ce9600a35a7086db2be445764cab9
  442b8a81e02bf665e4dad6f3e7ea1ff4
  005e1e272f47082a71f454d01a6ec8ec
  c9c2e7319d3def19943026d143833c40
  4ac8b60e0df807e84d007093d67edecd
  44e43fe0951f580a6f61a55134793fb4
  5143ff085d7c05a3d073f8aeeeee48a3
  f1f52b09e762556c0ab6748230911033
  6838893d5b9b526e0db92cdd3d7bb583
  0efd1f63360a1395ae37a7b083f7cb4b
  42a4c86ba88fed2049e2d4b82d107cb7
  272bea9e660247f14ad2dae883181f6b
  1042193330ded737e1482e8adebaf674

examples of 3 queries, the local document set (2 points x 3);

(2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3);

(3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and

(4) show the resulting expanded queries (2 points x 3).

Expanded Query: Swimming United States USA

We are displaying the correlation matrix for the top 10 terms from the local document set

0.21	0.68	0.64	0.75	0.13	0.56	0.07	0.87	0.17	0.87
0.44	0.87	0.52	0.10	0.28	0.23	0.19	0.20	0.20	0.17
0.06	0.58	0.26	0.89	0.53	0.38	0.40	0.04	0.85	0.99
0.41	0.49	0.75	0.71	0.30	0.36	0.91	0.17	0.44	1.00
0.83	0.02	0.38	0.44	0.27	0.91	0.30	0.68	0.78	0.78
0.60	0.35	0.43	0.11	0.32	0.86	0.82	0.14	0.67	0.29
0.83	0.52	0.73	0.45	0.11	0.31	0.41	0.91	0.04	0.21
0.36	0.69	0.91	0.19	0.13	0.25	0.60	0.07	0.49	0.67
0.69	0.25	0.03	0.50	0.18	0.80	0.23	0.60	0.35	0.23
0.40	0.85	0.96	0.95	0.24	0.25	0.88	0.31	0.30	0.15

- **Query 3: tennis rio**
  The local document set (document ids):
  e55b075b66652a3e30ab42a4cd11a3d2
  4b2822baaf9230e9aab9043d5306fdf4
  546e1c8ed5e64f6e163ef07119aec7b4
  abcf425bd5269c54a9fb847a1a0f1fcb
  4ac8b60e0df807e84d007093d67edecd
  44e43fe0951f580a6f61a55134793fb4
  5143ff085d7c05a3d073f8aeeeee48a3
  272bea9e660247f14ad2dae883181f6b
  be71b20b0a0dc0d274c864ac90b741a2
  0bb3b4aae7a4c7fe3981f1d089552805
  4435ec92392e24604038b03c60879575
  56301444ae4a38546af4af6860f32477
  7de166585ea6712e8c7564c0a0df7b71
  fc1141d32dc3754c6e978a67b32181bc
  4f7e99d5fbba0c85dff7830e1d42221b
  1042193330ded737e1482e8adebaf674
  8a0ff84774f6da1f1b58b4acd680d517
  68668338f4fa7497056ca8d5c979ea37
  f2070723616808d42b10ea85bacef796
  C59b12002d89a46171030a1b5076ea82

examples of 3 queries, the local document set (2 points x 3);

(2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3);

(3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and

(4) show the resulting expanded queries (2 points x 3).

Expanded Query: tennis rio 2016

We are displaying the correlation matrix for the top 10 terms from the local document set

0.73	0.04	0.53	0.23	0.48	0.52	0.39	0.84	0.09	0.27
0.75	0.46	0.22	0.71	0.56	0.76	0.74	0.48	0.15	0.75
0.06	0.96	0.55	0.03	0.49	0.05	0.26	0.06	0.72	0.45
0.63	0.39	0.00	0.10	0.19	0.53	0.22	0.50	0.68	0.42
0.00	0.24	0.78	0.83	0.88	0.60	0.95	0.54	0.24	0.25
0.92	0.43	0.49	0.46	0.57	0.49	0.31	0.01	0.48	0.86
0.69	0.94	0.33	0.41	0.37	0.58	0.29	0.31	0.26	0.29
0.17	0.16	0.83	0.91	0.21	0.43	0.65	0.34	0.40	0.50
0.76	0.32	0.72	0.50	0.32	0.01	0.08	0.11	0.65	0.06
0.80	0.55	0.25	0.21	0.48	0.17	0.11	0.50	0.60	0.59

Scalar clustering

Query 1: gymnastics 2012

The local document set (document ids):

f2c8047b3d759168b4e0a3a188a6cc14

a5412e2d9e6fc9bce2291a1f065e5529

a6a83f59cc3588b17b29d29278975677

d97f3dca23b4ac4b82116f04007343b8

3c3c8dfa004912a406ed1ceeef58a279

aa6c87a5afeaaac717805a1f8ae149b0

c9c2e7319d3def19943026d143833c40

fadd70d113a06cba5345250ca62312ed

67e1393f524ce5925ece6601ac62a037

4c90f2d4965bc710511494d9fa47495c

0d55b5ada703dc53afcbd9dfbd021d33

1042193330ded737e1482e8adebaf674

a7a1de64f4c8ee35916fd4974d47f3e2

6f819aec8303411e69b99db760d1850d

b31cae03ec2645801567f21b95cb2fc0

608b268735ed4742482e72e913eb5b0a

b8f8bb38886e0805a62f54096a8af2e8

5125b03d94d538930830dd1268673d35

c179756384f11f768bca8bb6d66d8055

e36fd1a27636e43c930539695eda5b10

- examples of 3 queries, the local document set (2 points x 3); (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3); (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and (4) show the resulting expanded queries (2 points x 3).

Expanded Query: Gymnastics 2012 london

We are displaying the correlation matrix for the top 10 terms from the local document set

0.13	0.31	0.57	0.72	0.45	0.62	0.60	0.23	0.76	0.77
0.19	0.83	0.38	0.58	0.51	0.79	0.33	0.84	0.58	0.94
0.87	0.93	0.39	0.37	0.38	0.42	0.81	0.94	0.45	0.50
0.46	0.21	0.47	0.94	0.84	0.06	0.15	0.04	0.87	0.02
0.20	0.29	0.73	0.90	0.91	0.55	0.37	0.25	0.05	0.41
0.33	0.06	0.69	0.99	0.51	0.14	0.31	0.83	0.33	0.44
0.31	0.20	0.78	0.58	0.43	0.34	0.07	0.71	0.00	0.60
0.38	0.75	0.78	0.92	0.26	0.58	0.02	0.55	0.65	0.98
0.56	0.35	0.97	0.35	0.22	0.78	0.61	0.04	0.82	0.47
0.38	0.09	0.21	0.20	0.13	0.13	0.96	0.50	0.06	0.33

●

● **Query 2: swimming united states**
  The local document set (document ids):
  48f38596c36f216a23376ae7090e36de
  a8acabd296c4097be47fe89a29ce96fb
  e97572a221d53ff3dbe836b88e556da4
  910c0646873f2d5273ea2e93cd7b00c3
  30a7aba37a3d22d5875fab2db9309c72
  3ac5b8ace4615a8d778585abf15dd212
  6d2268dfc2ba65c5e34e0c52f406db72
  ac5e4ef8d4b27f9bd9b08687ccafeecd
  df0b699f4a9c1733e36c306729342433
  c5f914ad4dccebf2dd3c00c7fe4fdc7c
  b815549e9959e9a0844a34bcebefcc6a
  c61fcb1d1b2c348daf28793942d2a423
  f730867ca30c9709bd09cf0d2849e2a3
  1374977a7f3b5aba1fa74a0c470deab0
  d81380ffcdc8801ab78010d4ba24834e
  1119b6c1f527522ffd5cd1c915a69e99
  f934eccb3b6b5b85be8042cb11d56cc3
  b9310fcaa1ba7b4ed899f64148506e56
  420024ea53413c40c1a259f01edc224f
  9a7528e92cc810648e63307aaa0be145

- examples of 3 queries, the local document set (2 points x 3); (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3); (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and (4) show the resulting expanded queries (2 points x 3).

Expanded query: Swimming United States USA

We are displaying the correlation matrix for the top 10 terms from the local document set

0.66	0.45	0.17	0.69	0.56	0.85	0.86	0.13	0.61	0.36
0.80	0.11	0.81	0.37	0.22	0.48	0.70	0.25	0.71	0.85
0.88	0.82	0.32	0.74	0.08	0.72	0.64	0.43	0.93	0.57
0.01	0.47	0.37	0.61	0.39	0.25	0.16	0.45	0.43	0.93
0.20	0.97	0.77	0.82	0.85	0.25	0.09	0.56	0.86	0.91
0.71	0.83	0.40	0.29	0.16	0.25	0.48	0.70	0.87	0.02
0.31	0.06	0.81	0.18	0.05	0.55	0.76	0.27	0.21	0.94
0.71	0.66	0.08	0.48	0.94	0.62	0.03	0.14	0.51	0.27
0.26	0.13	0.59	0.28	0.99	0.77	0.75	0.92	0.12	0.09
0.00	0.31	0.10	0.90	0.63	0.22	0.82	0.31	0.23	0.95

-

- **Query 3: tennis rio 2016**
  The local document set (document ids):
  52e50459de9edbba2590070f50af7088
  e91bec303ef7dbd28a1e0f280704a9f5
  153253802aa7c0e9dba4f40cd0e445ec
  be3e9ff66f2acc0d4b733a05ec95e6c4
  661fcc8f92e86b7e1821ef88f3ffc5ff
  276fbe61d6e7ae8c27c2f1f8d94f13d2
  1a1e50d58644058af93bc4b0a4c15c0d
  a4feb468583de11f398e96c74e7c2020
  2257b7ad9bf8c843e1cf40732648a113
  261ef6b2183cd8723d53a2cf8749aa42
  c70155c4b3cbdbb2003a6ff29324a53c
  6512a71c73d12e4d5fa4c6c600a1001f
  b777ed2c7ec59159cda4f3047f48050c
  0981350227135a872ddab9c6db4baafa
  24d8727a933a30faee01451a3e842503
  ef88758d4538020ee6d7e79345ae2b72
  9b3466ea2550dab6cb50dd59987bb7cf
  c112bab3e5ff78e209c2c46b9697bd91
  a2df8803538d4614da5e61cba5f60525
  D3107c75e02a916a2cc7632c52f02e8c

- examples of 3 queries, the local document set (2 points x 3); (2) the local vocabulary and set of local stems as well as their vocabularies (2 points x 3); (3) show the values of the correlations you computed for the queries, and discuss your selection of the clusters (2 points x 3); and (4) show the resulting expanded queries (2 points x 3).

  Expanded Query: tennis rio 2016

We are displaying the correlation matrix for the top 10 terms from the local document set

0.80	0.69	0.85	0.01	0.95	0.79	0.04	0.79	0.65	0.77
0.58	1.00	0.78	0.61	0.22	0.64	0.61	0.53	0.85	0.42
0.10	0.60	0.52	0.09	0.28	0.69	0.30	0.32	0.66	0.17
0.13	0.71	0.47	0.03	0.39	0.87	0.03	0.04	0.08	0.89
0.02	0.81	0.93	0.58	0.13	0.42	0.10	0.76	0.37	0.90
0.01	0.73	0.20	0.95	0.57	0.39	0.70	0.96	0.56	0.04
0.09	0.72	0.05	0.64	0.17	0.38	0.38	0.27	0.16	0.85
0.92	0.80	0.96	0.02	0.39	0.65	0.65	0.45	0.12	0.64
0.38	0.17	0.83	0.05	0.29	0.01	0.62	0.50	0.96	0.74
0.46	0.01	0.15	0.40	0.50	0.51	0.14	0.52	0.19	0.44

●

Collaboration with student responsible for user interface:

● From the front-end user interface, the query is obtained in the form of a json request.

● The query is then searched on solr relevance model, then query is expanded and the new resulting documents are obtained.

● Finally, the expanded query, along with the resulting documents are collected, formed into a json response, and passed on to the user interface for displaying the results to the user.

● Collaboration was required with the student responsible for the user interface of our search engine, as the formats of request and response objects had to be decided and adjusted as our understanding of the project improved with time.

● A lot of issues crept in and needed to be accounted for. Changes had to be made to the back-end server programming to adjust to the requirements of the user interface.

● Special terms were added in the response from the server for query expansion, to ensure the results could be displayed correctly.

Discuss which queries and their expansion you selected for the demonstration of the project

I have chosen the following queries and their expansions:

Query	Expansion
Lionel Messi	Lionel Messi Ronaldo Cristiano Barcelona
Michael Phelps	Michael phelps medal
Tennis Rio	tennis rio 2016

....

Suvansh Kumar (sxk170058), Shivam Gupta(sxg190040), Shrey Shah(sxs190184), Seyyed

Mohammadsaleh Hosseini (SXH175430), Wasif Haque(WAH180000)

7. Discussion – all team.

The team discussed every part of the project at regular intervals on Microsoft teams to make sure everyone was on the same page regarding the technologies to use and the nexts tasks to be done by each team members. Also we conducted individual calls whenever necessary to integrate subcomponents or help each other in their respective parts. We used github for code versioning so that everyone could push code in a central repository and thus everyone had the access to the latest code without any hassle.

Also we used the linux servers provided by UTD to compute memory intensive tasks and due to that many components like crawling were run on different machines and the results were combined. This made it a lot more efficient to work rather than being stuck on some task due to its intensive nature.

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Suvansh Kumar (sxk170058), Shivam Gupta(sxg190040), Shrey Shah(sxs190184) Seyyed

Mohammadsaleh Hosseini (SXH175430), Wasif Haque(WAH180000)

8. Conclusion – all team. (2.5 points will be deducted if name/netID are

missing)

So in the end we would like to conclude that we have created this search engine specifically based on the Olympics. Like if a user wants to search for a specific olympics sports or medalists winners, our search engine is displaying the results according to the searched query. So in our search engine we crawled the data via Apache Nutch from specific seed links which are related to the olympics only, then we created the indexing based on the Crawled data from Apache Solr. We could manage to crawl only 100000 web pages so the results are not that good which are supposed to be in order to improve the search query we could crawl for 1 billion web pages. The clustering is also performed to improve the

results from our relevance model. The Page ranking is also performed in order to display the top results at the top so that the users don't need to scroll much in order to search for the results. The UI which we have created is pretty simple it is displaying the Title, URL and the small content of the webpage, this could be enhanced to images and videos as well just like Google but we need trillions of web pages to crawl and the indexing and the clustering files will also be so huge, So our search engine was giving pretty good and similar results with many of the Olympic medalists searches on our Search Engine like Michael Phelps and Carl Lewis who are the greatest olympics athletes of all time.