Name: Subrato Tapaswi	Class/Roll No.: D16AD/60	Grade:

Title of Experiment: Page Rank in PySpark

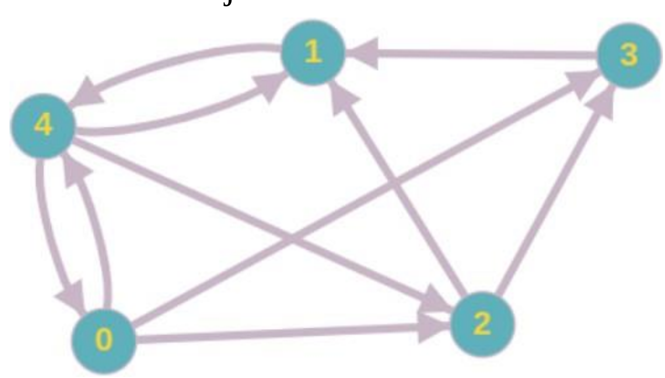
Objective of Experiment: To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. To enable students to have skills that will help them to solve complex real-world problems in decision support.

Outcome of Experiment: Collect, manage, store, query and analyze various forms of Big Data. Interpretbusiness models and scientific computing paradigms, and apply software tools for big data analytics.

Problem Statement: To study and implement a Page Rank algorithm using PySpark.

Theory: The PageRank algorithm or Google algorithm was introduced by Larry Page,one of the founders of Google. It was first used to rank web pages in the Google search engine. Nowadays, it is more and more used in many different fields, for example in ranking users in social media etc… What is fascinating with the PageRank algorithm is how to start from a complex problem and end up with a verysimple solution. You just need to have some basics in algebra and Markov Chains. Here, we will use ranking web pages as a use case to illustrate the PageRank algorithm.

The web can be represented like a directed graph where nodes represent the web pages and edges form links between them. Typically, if a node (web page) i is linked to a node j, it means that i refers to j.



Algorithm:

- Generates a probability distribution for web page likelihood.
- Applicable to collections of any size.
- Assumes even distribution among documents initially.
- Requires multiple iterations to refine PageRank values.
- Probabilities are numeric values between 0 and 1.
- A PageRank of 0.5 equates to a 50% chance of clicking a random link to the document.

Dataset used:

Kaggle dataset link: https://www.kaggle.com/pappukrjha/google-web-graph

# FromNodeId	ToNodeId
0	11342
0	824020
0	867923
0	891835
11342	0
11342	27469
11342	38716
11342	309564
11342	322178
11342	387543
11342	427436
11342	538214
11342	638706
11342	645018
11342	835220
11342	856657
11342	867923
11342	891835
824020	0
824020	91807
824020	322178
824020	387543
824020	417728
824020	438493
824020	500627
824020	535748
824020	695578
824020	867923
824020	891835
867923	0
867923	11342

Output:

Move the data into hadoop file system:

```
[cloudera@quickstart ~]$ hdfs dfs -put /home/cloudera/Desktop/web-Google.txt .
[cloudera@quickstart ~]$ hdfs dfs -ls
Found 3 items
drwxr-xr-x   - cloudera cloudera          0 2023-10-07 07:18 Desktop
drwxr-xr-x   - cloudera cloudera          0 2023-10-07 07:19 PageRank
-rw-r--r--   1 cloudera cloudera   75380115 2023-10-07 08:02 web-Google.txt
[cloudera@quickstart ~]$
```

Start Pyspark , Compute Contrib function , RDD named links:

```
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 1.6.0
      /_/

Using Python version 2.6.6 (r266:84292, Jul 23 2015 15:22:56)
SparkContext available as sc, HiveContext available as sqlContext.
>>> def computeContribs(neighbors,rank):
...     for neighbor in neighbors:
...             yield(neighbor,rank/len(neighbors))
...
>>> links = sc.textFile('web-Google.txt')\
...     .map(lambda line: line.split())\
...     .map(lambda pages: (pages[0],pages[1]))\
...     .distinct()\
...     .groupByKey()\
...     .persist()
23/10/07 09:47:48 WARN shortcircuit.DomainSocketFactory: The short-circuit local
 reads feature cannot be used because libhadoop cannot be loaded.
>>>
```

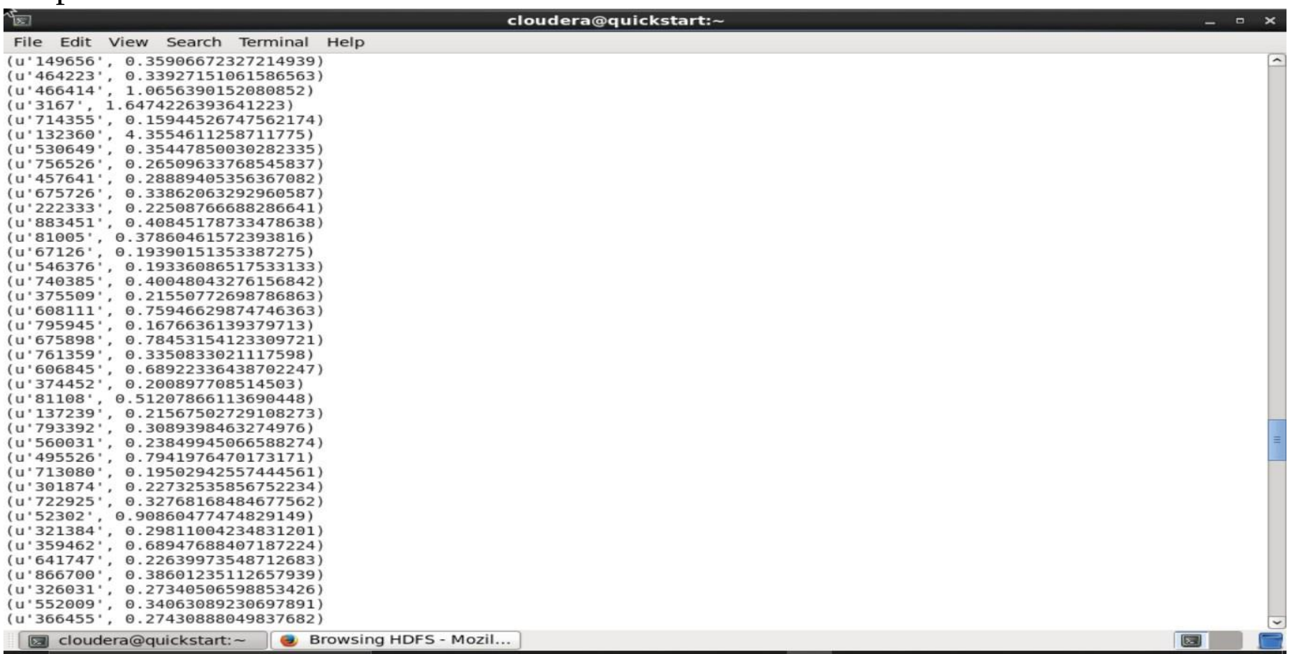
Ranks RDD storing the ranks data , Loop in order to calculate contribs and ranks:

```
>>> ranks = links.map(lambda (page,neighbors):(page,1.0))
>>> for x in xrange(10):
...     contribs=links\
...     .join(ranks)\
...     .flatMap(lambda (page,(neighbors,rank)):computeContribs(neighbors,rank))
...     ranks = contribs\
...     .reduceByKey(lambda v1,v2: v1+v2)\
...     .map(lambda (page,contrib):(page,contrib * 0.85 + 0.15))
...
>>>
```

Collect all ranks:

```
>>> for rank in ranks.collect():
...     print rank
...
```

Output:



```
cloudera@quickstart:~
File Edit View Search Terminal Help
(u'149656', 0.35906672327214939)
(u'464223', 0.33927151061586563)
(u'466414', 1.0656390152080852)
(u'3167', 1.6474226393641223)
(u'714355', 0.15944526747562174)
(u'132360', 4.3554611258711775)
(u'530649', 0.35447850030282335)
(u'756526', 0.26509633768545837)
(u'457641', 0.28889405356367082)
(u'675726', 0.33862063292960587)
(u'222333', 0.22508766688286641)
(u'883451', 0.40845178733478638)
(u'81005', 0.37860461572393816)
(u'67126', 0.19390151353387275)
(u'546376', 0.19336086517533133)
(u'740385', 0.40048043276156842)
(u'375509', 0.21550772698786863)
(u'608111', 0.75946629874746363)
(u'795945', 0.1676636139379713)
(u'675898', 0.78453154123309721)
(u'761359', 0.3350833021117598)
(u'606845', 0.68922336438702247)
(u'374452', 0.200897708514503)
(u'81108', 0.51207866113690448)
(u'137239', 0.21567502729108273)
(u'793392', 0.3089398463274976)
(u'560031', 0.23849945066588274)
(u'495526', 0.7941976470173171)
(u'713080', 0.19502942557444561)
(u'301874', 0.22732535856752234)
(u'722925', 0.32768168484677562)
(u'52302', 0.9086047747482914 9)
(u'321384', 0.29811004234831201)
(u'359462', 0.68947688407187224)
(u'641747', 0.22639973548712683)
(u'866700', 0.38601235112657939)
(u'326031', 0.27340506598853426)
(u'552009', 0.34063089230697891)
(u'366455', 0.27430888049837682)
cloudera@quickstart:~    Browsing HDFS - Mozil...
```

```
cloudera@quickstart:~
File Edit View Search Terminal Help
(u'465424', 0.25371064727868681)
(u'533846', 0.73499594380152833)
(u'178845', 0.82440207103463126)
(u'40574', 0.36893577023839097)
(u'688401', 0.15138612284601208)
(u'219540', 0.52086559746269279)
(u'862612', 0.1682011789239215)
(u'225840', 0.22112641401014263)
(u'578427', 1.9556828100899866)
(u'778461', 0.16614734675556039)
(u'772689', 0.25596658934028033)
(u'640067', 0.16888128780597281)
(u'494840', 0.16121393336472756)
(u'469947', 0.17602449281860807)
(u'557956', 0.15761193051022804)
(u'751932', 0.25512148001903612)
(u'439276', 0.37354030602742794)
(u'577774', 0.59186709809304527)
(u'13820', 0.46509307311203074)
(u'465394', 0.39391337311985208)
(u'103094', 0.20685839318121693)
(u'526431', 0.15166997681471525)
(u'242883', 0.39889751369909454)
(u'384934', 0.81738301227365884)
(u'5631', 0.63490126285120863)
(u'634794', 0.23873780776863762)
(u'225664', 1.6756683479047332)
(u'257481', 0.28509560395135675)
(u'245352', 0.17493958820692246)
(u'65395', 0.19594183330052109)
(u'686962', 1.4770699228362925)
(u'838440', 0.21160243776847804)
```

Saving the RDD as text file:

```
>>> ranks.count()
654830
>>> ranks.take(5)
[(u'681601', 0.20267241923465629), (u'880578', 0.9407418091371379), (u'89370', 0.38540858498193531), (u'460068', 0.4239354087
691638), (u'684237', 0.23593743836588738)]
>>> ranks.saveAsTextFile('pageRanks_output')
>>> 
```

Browsing HDFS - Mozilla Firefox

quickstart.cloudera:50070/explorer.html#/user/cloudera

Hadoop | Overview | Datanodes | Snapshot | Startup Progress | Utilities

Browse Directory

/user/cloudera

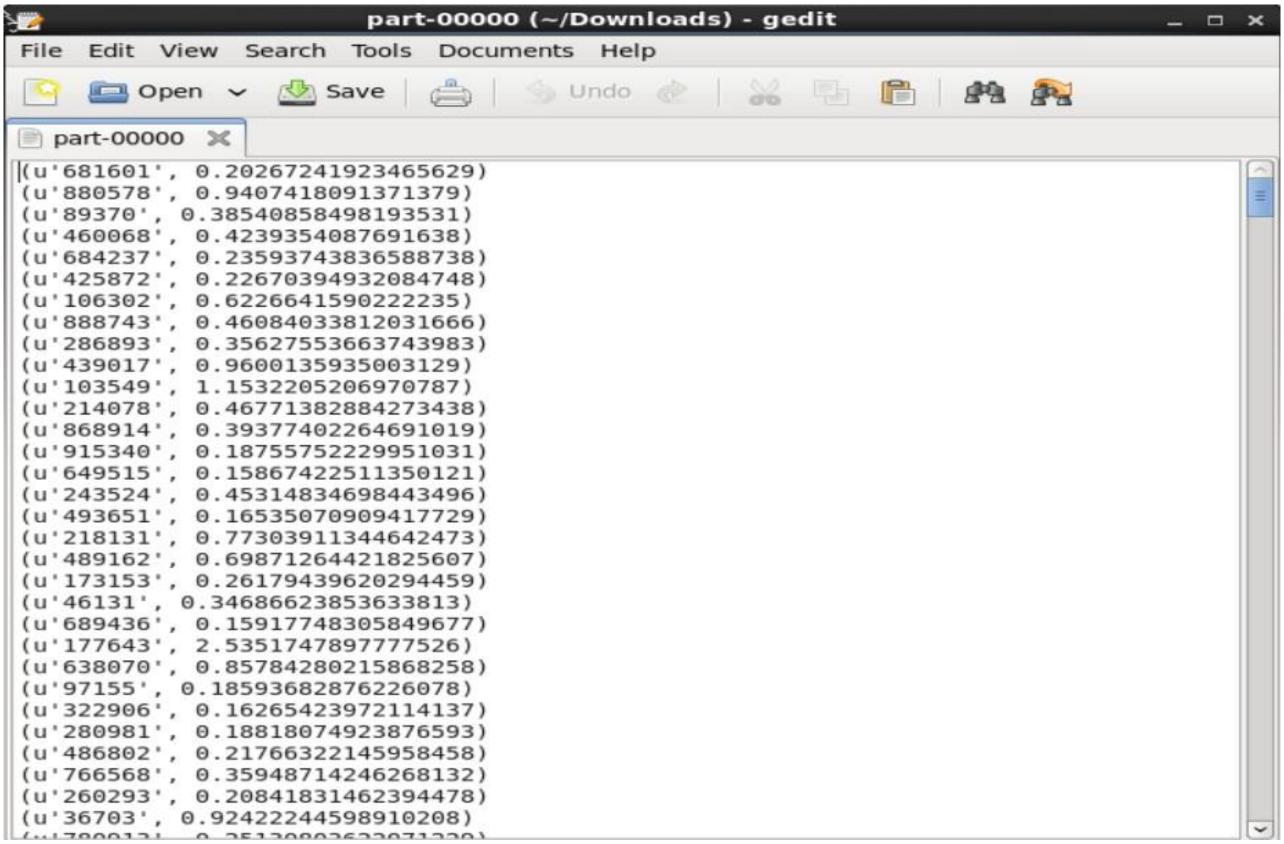
Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
drwxr-xr-x	cloudera	cloudera	0 B	Sat Oct 07 07:18:48 -0700 2023	0	0 B	Desktop
drwxr-xr-x	cloudera	cloudera	0 B	Sat Oct 07 07:19:22 -0700 2023	0	0 B	PageRank
drwxr-xr-x	cloudera	cloudera	0 B	Sat Oct 07 09:30:59 -0700 2023	0	0 B	pageRanks_output
-rw-r--r--	cloudera	cloudera	71.89 MB	Sat Oct 07 08:02:35 -0700 2023	1	128 MB	web-Google.txt

Hadoop, 2017.

Browse Directory

/user/cloudera/pageRanks_output

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
-rw-r--r--	cloudera	cloudera	0 B	Sat Oct 07 09:30:59 -0700 2023	1	128 MB	_SUCCESS
-rw-r--r--	cloudera	cloudera	951.54 KB	Sat Oct 07 09:30:41 -0700 2023	1	128 MB	part-00000
-rw-r--r--	cloudera	cloudera	958.22 KB	Sat Oct 07 09:30:41 -0700 2023	1	128 MB	part-00001
-rw-r--r--	cloudera	cloudera	946.29 KB	Sat Oct 07 09:30:41 -0700 2023	1	128 MB	part-00002
-rw-r--r--	cloudera	cloudera	947.09 KB	Sat Oct 07 09:30:41 -0700 2023	1	128 MB	part-00003
-rw-r--r--	cloudera	cloudera	939.09 KB	Sat Oct 07 09:30:44 -0700 2023	1	128 MB	part-00004
-rw-r--r--	cloudera	cloudera	942.88 KB	Sat Oct 07 09:30:44 -0700 2023	1	128 MB	part-00005
-rw-r--r--	cloudera	cloudera	946.15 KB	Sat Oct 07 09:30:44 -0700 2023	1	128 MB	part-00006
-rw-r--r--	cloudera	cloudera	952.92 KB	Sat Oct 07 09:30:43 -0700 2023	1	128 MB	part-00007
-rw-r--r--	cloudera	cloudera	944.68 KB	Sat Oct 07 09:30:44 -0700 2023	1	128 MB	part-00008
-rw-r--r--	cloudera	cloudera	946.11 KB	Sat Oct 07 09:30:45 -0700 2023	1	128 MB	part-00009
-rw-r--r--	cloudera	cloudera	948.66 KB	Sat Oct 07 09:30:45 -0700 2023	1	128 MB	part-00010
-rw-r--r--	cloudera	cloudera	955.91 KB	Sat Oct 07 09:30:46 -0700 2023	1	128 MB	part-00011




```
(u'681601', 0.20267241923465629)
(u'880578', 0.9407418091371379)
(u'89370', 0.38540858498193531)
(u'460068', 0.4239354087691638)
(u'684237', 0.23593743836588738)
(u'425872', 0.22670394932084748)
(u'106302', 0.6226641590222235)
(u'888743', 0.46084033812031666)
(u'286893', 0.35627553663743983)
(u'439017', 0.9600135935003129)
(u'103549', 1.1532205206970787)
(u'214078', 0.46771382884273438)
(u'868914', 0.39377402264691019)
(u'915340', 0.18755752229951031)
(u'649515', 0.15867422511350121)
(u'243524', 0.45314834698443496)
(u'493651', 0.16535070909417729)
(u'218131', 0.77303911344642473)
(u'489162', 0.69871264421825607)
(u'173153', 0.26179439620294459)
(u'46131', 0.34686623853633813)
(u'689436', 0.15917748305849677)
(u'177643', 2.5351747897777526)
(u'638070', 0.85784280215868258)
(u'97155', 0.18593682876226078)
(u'322906', 0.16265423972114137)
(u'280981', 0.18818074923876593)
(u'486802', 0.21766322145958458)
(u'766568', 0.35948714246268132)
(u'260293', 0.20841831462394478)
(u'36703', 0.92422244598910208)
```

Results and Discussions: PySpark's Page Rank algorithm assigned rankings to web pages, highlighting their importance in the web graph. Its distributed computing efficiently handled large datasets, benefiting web search and recommendations, and offers potential for better search engine results.