Page Rank: GCP

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Contents

Introduction

PageRank is a search engine established by Google that was later adopted by webmasters to assess the quality of website with reference to backlinking and SEO

The original PageRank algorithm was described by Lawrence Page and Sergey Brin in several publications. It is given by
$PR(A) = (1-d) + d (PR(T1)/C(T1) + ... + PR(Tn)/C(Tn))$
Where

PR(A) is the PageRank of page A,
PR(Ti) is the PageRank of pages Ti which link to page A,
C(Ti) is the number of outbound links on page Ti and
d is a damping factor which can be set between 0 and 1.

Explanation

We consider a small web of three pages, A, B, and C, with links from page A to pages B and C, from page B to page C, and from page C to page A. Page and Brin state that the damping factor d is often set around 0.85.

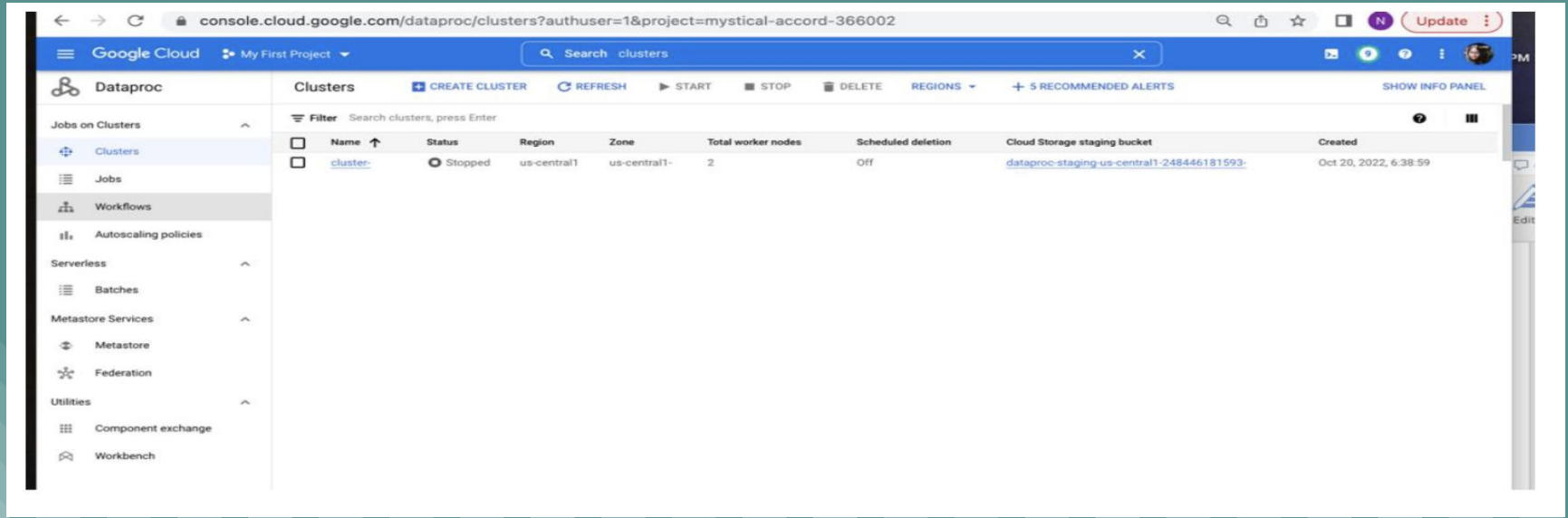
If there is no user input, PageRank will remain constant. Impact of a web page's PageRank of 1-d the least PageRank Input Web Pages

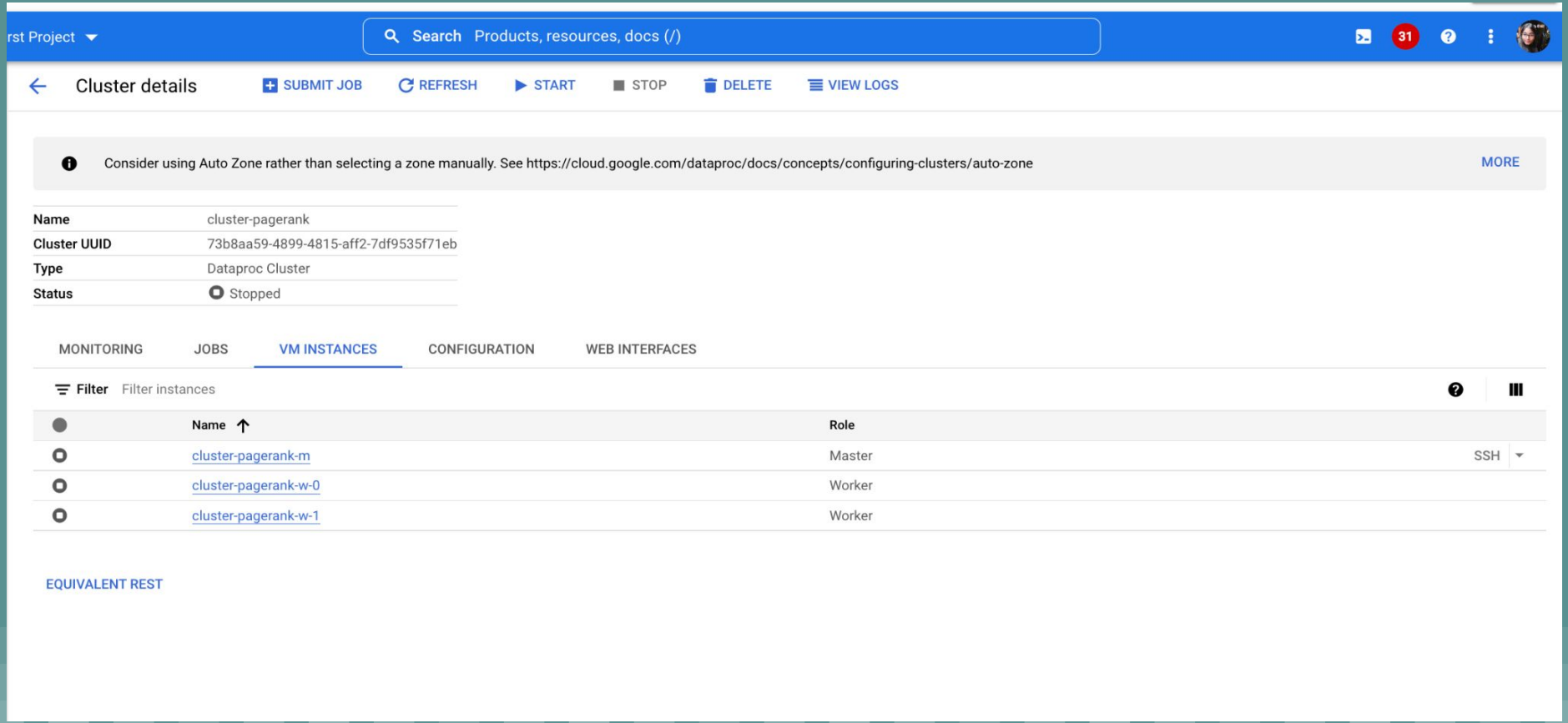
The better, the more input web pages.

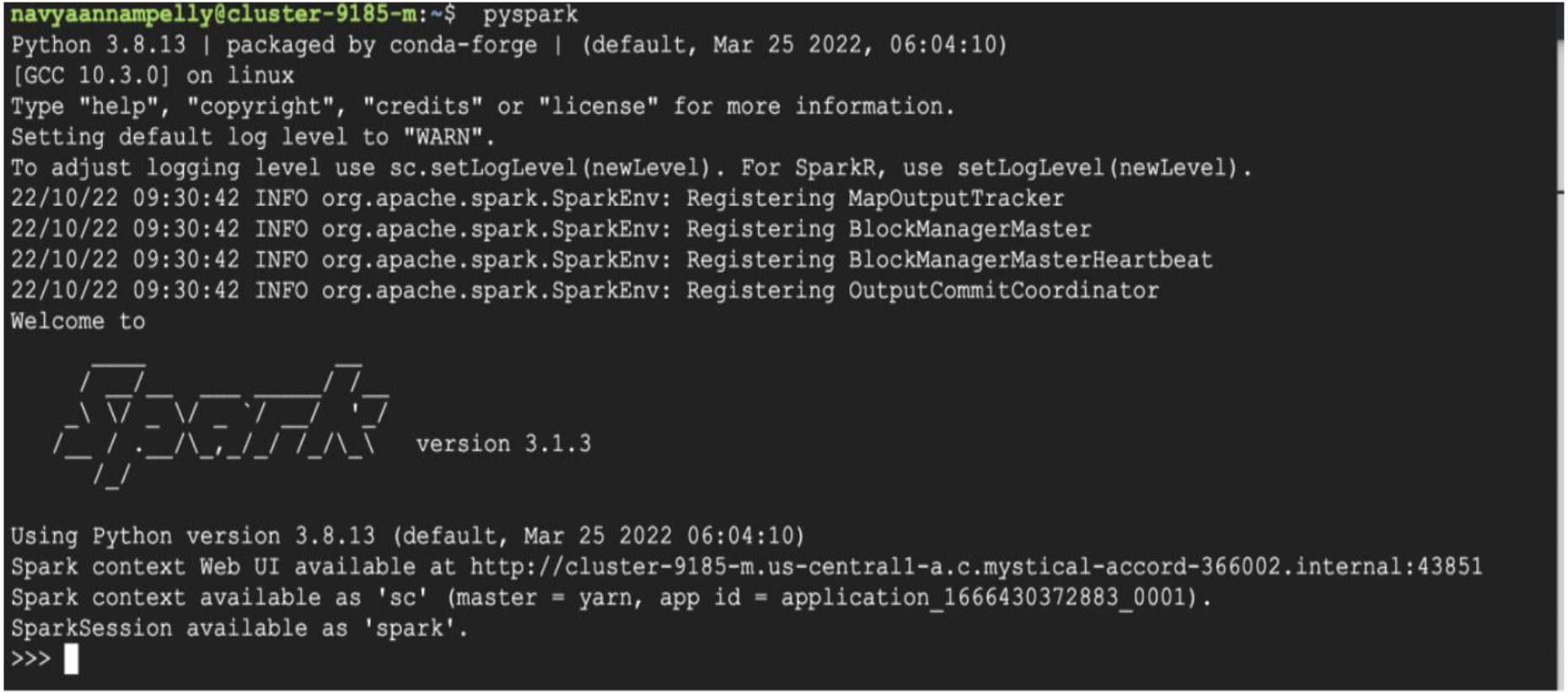
An input web page's PageRank should be as high as pos

SET UP GCP

- Enable the google compute engine API
- Create the Dataporc Cluster and configure it.
- Launch the Dataporc Cluster
- Conneting the master to the SSH.



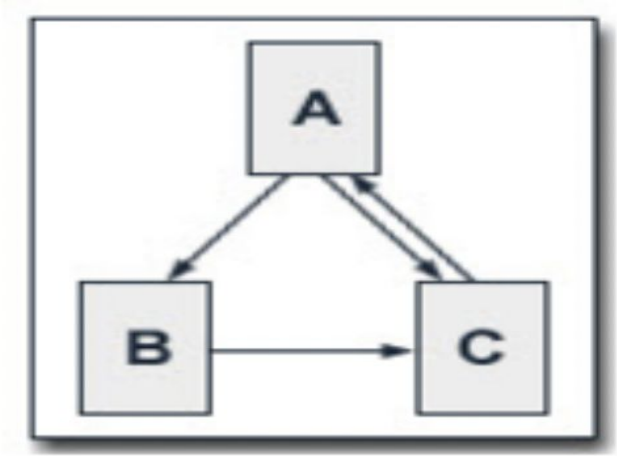

rst Project
Search Products, resources, docs (/)
31
Cluster details
SUBMIT JOB
REFRESH
START
STOP
DELETE
VIEW LOGS
Consider using Auto Zone rather than selecting a zone manually. See https://cloud.google.com/dataproc/docs/concepts/configuring-clusters/auto-zone
MORE
Name cluster-pagerank
Cluster UUID 73b8aa59-4899-4815-aff2-7df9535f71eb
Type Dataproc Cluster
Status Stopped
MONITORING
JOBS
VM INSTANCES
CONFIGURATION
WEB INTERFACES
Filter Filter instances
Name
Role
cluster-pagerank-m Master SSH
cluster-pagerank-w-0 Worker
cluster-pagerank-w-1 Worker
EQUIVALENT REST


navyaannampelly@cluster-9185-m:~$ pyspark
Python 3.8.13 | packaged by conda-forge | (default, Mar 25 2022, 06:04:10)
[GCC 10.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
22/10/22 09:30:42 INFO org.apache.spark.SparkEnv: Registering MapOutputTracker
22/10/22 09:30:42 INFO org.apache.spark.SparkEnv: Registering BlockManagerMaster
22/10/22 09:30:42 INFO org.apache.spark.SparkEnv: Registering BlockManagerMasterHeartbeat
22/10/22 09:30:42 INFO org.apache.spark.SparkEnv: Registering OutputCommitCoordinator
Welcome to
version 3.1.3
Using Python version 3.8.13 (default, Mar 25 2022 06:04:10)
Spark context Web UI available at http://cluster-9185-m.us-central1-a.c.mystical-accord-366002.internal:43851
Spark context available as 'sc' (master = yarn, app id = application_1666430372883_0001).
SparkSession available as 'spark'.
>>>

Manual Solution and Design

Assuming

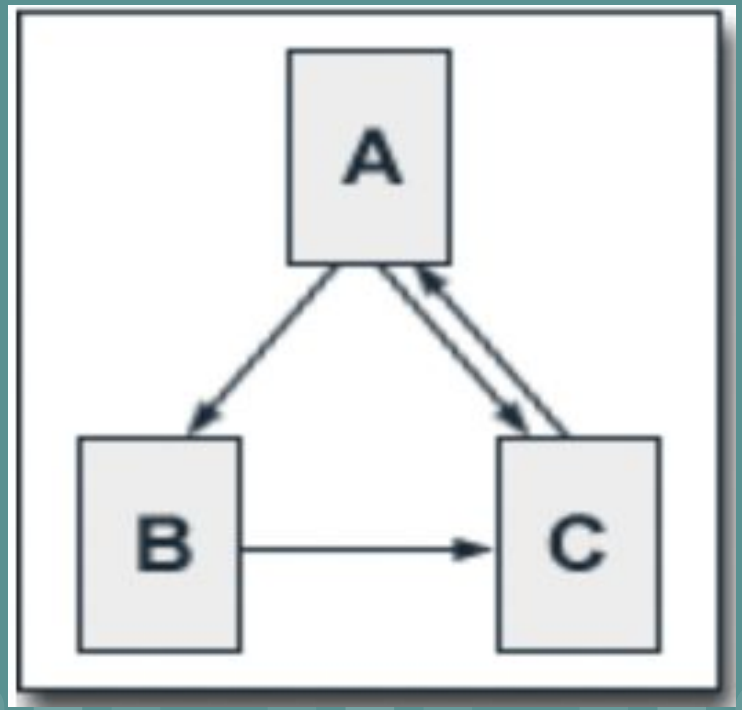
- the initial PageRank value for each webpage is 1.
- the damping factor is 0.85
- the relation of the webpages is:



Manual Solution and Design

First Iteration:

1. PR(A)
   = (1-d) + d * (PR(C) / 1
   = (1-0.85) + 0.85 * (1)
   = 1
2. PR(B)
   = (1-d) + d * (PR(A) / 2)
   = (1-0.85) + 0.85 * 0.5
   = 0.575
3. PR(C)
   = (1-d) + d * (PR(A) / 2 + PR(B) / 1)
   = (1-0.85) + 0.85 * (0.5 + 1)
   = 1.425



Manual Solution and Design

Second Iteration:

1. PR(A)
   = 1 – 0.85 + 0.85 * 1.425

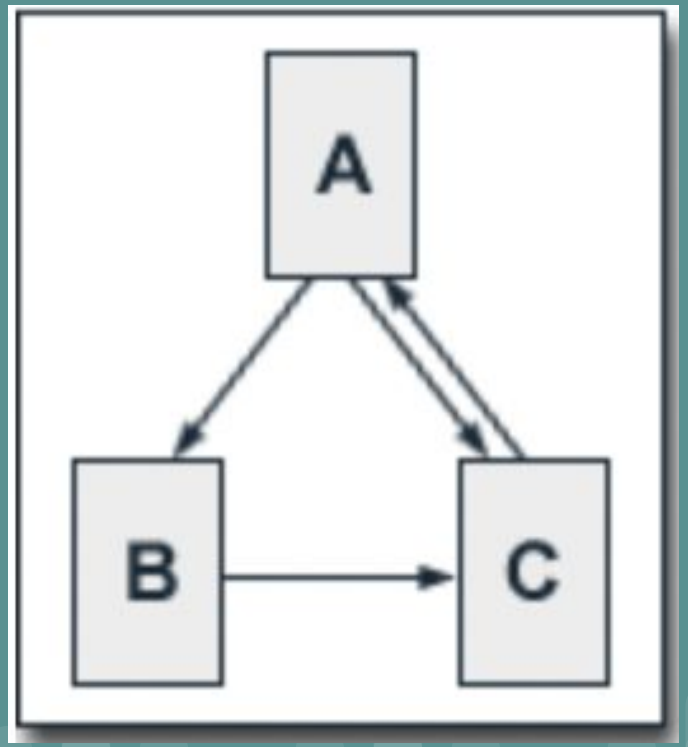
   = 1.36125

2. PR(B)
   = 1 – 0.85 + 0.85 * 0.5

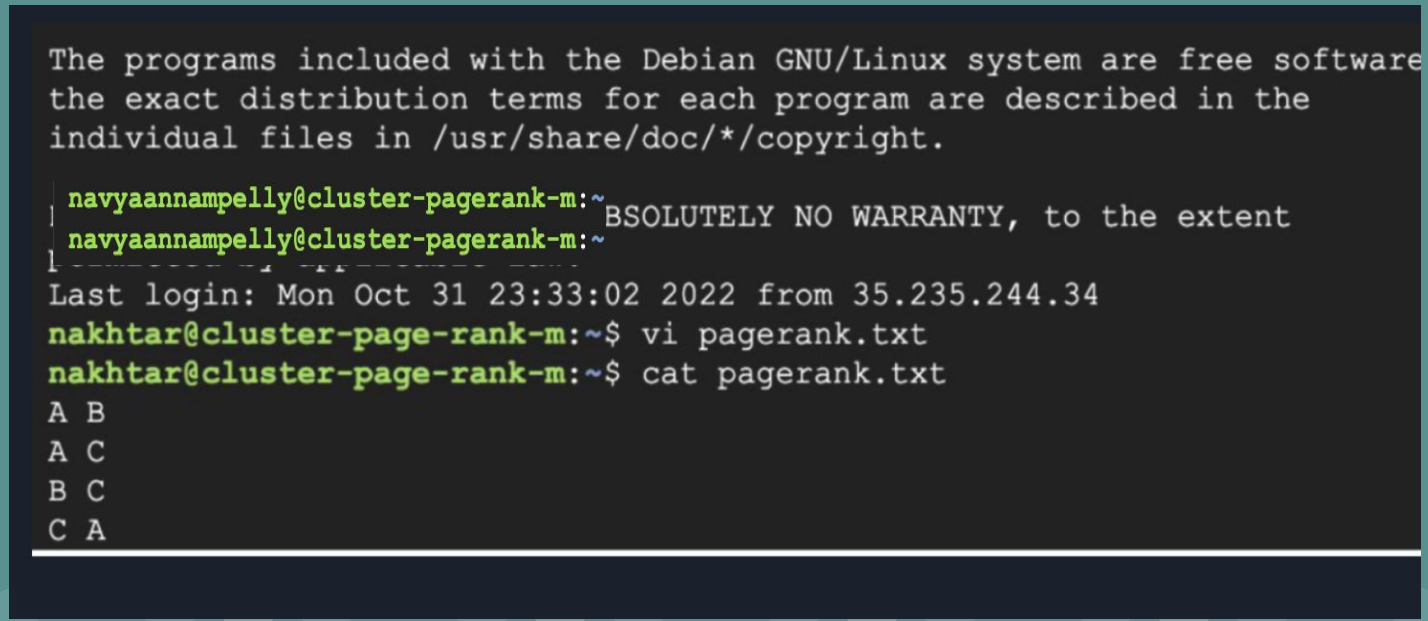
   = 0.575

3. PR(C)
   1 – 0.85 + 0.85 * 1.075

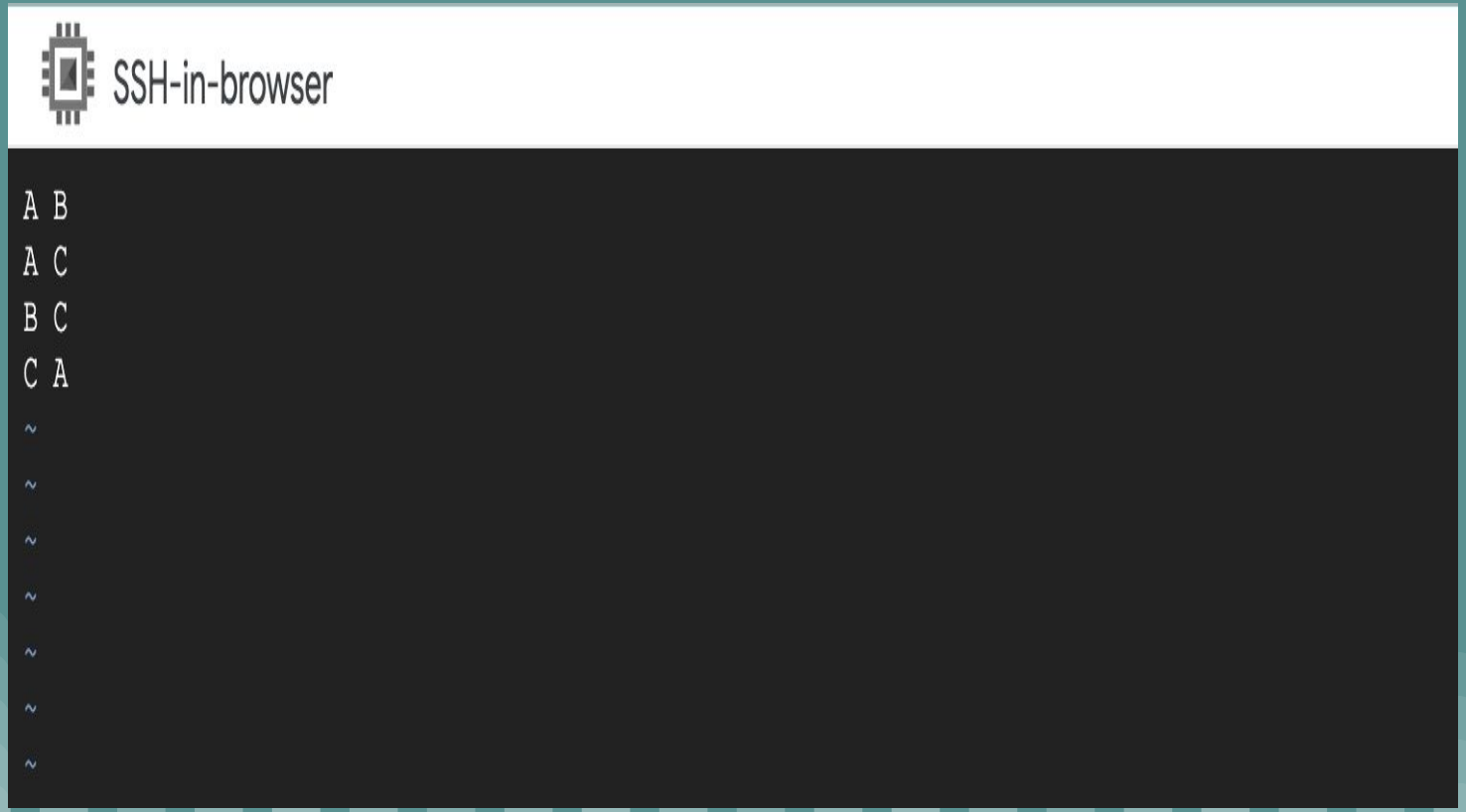
   = 1.06375



Implementation



Implementation



PageRank + Scala + GCP

Create new directory on cluster i-e mydata:

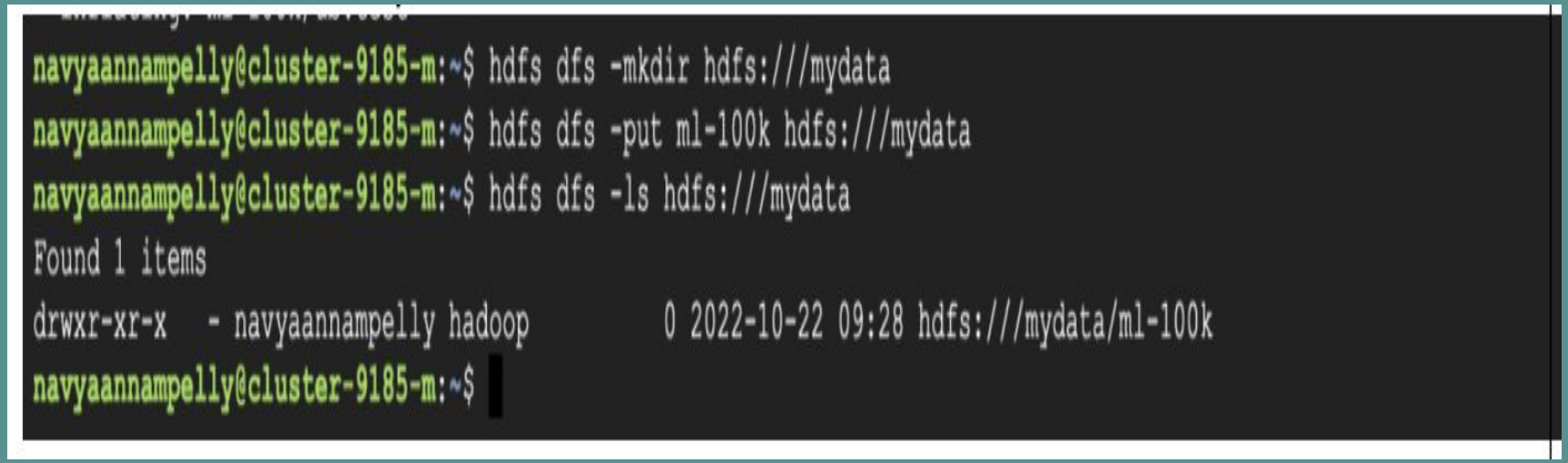
hdfs dfs -mkdir hdfs:///mydata

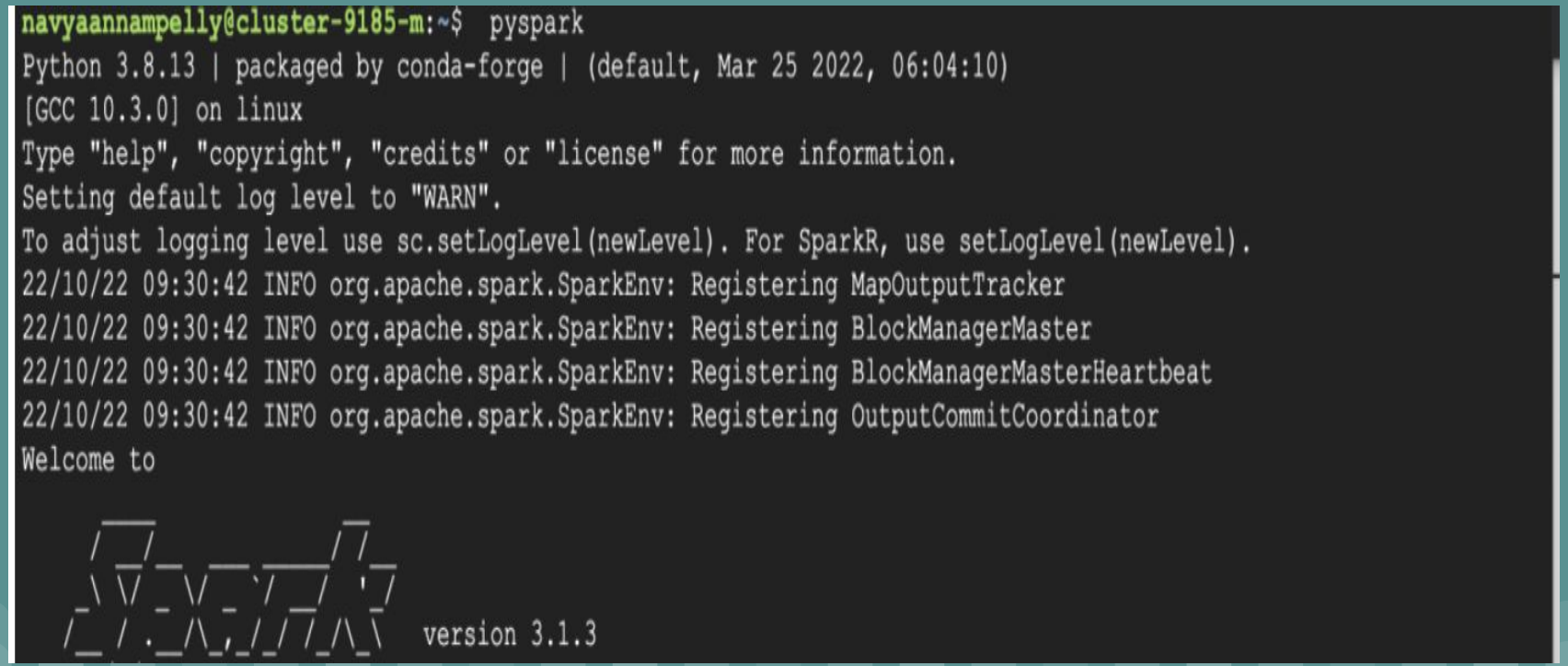
```
navyaannampelly@cluster-pagerank-m:~$ hdfs dfs -mkdir hdfs:///mydata
```

Keep the pagerank.txt file into hdfs directory:

hdfs dfs -put pagerank_data.txt hdfs:///mydata

```
navyaannampelly@cluster-pagerank-m:~$ hdfs dfs -put pagerank_data.txt hdfs:///mydata
```


navyaannampelly@cluster-9185-m:~$ hdfs dfs -mkdir hdfs:///mydata
navyaannampelly@cluster-9185-m:~$ hdfs dfs -put ml-100k hdfs:///mydata
navyaannampelly@cluster-9185-m:~$ hdfs dfs -ls hdfs:///mydata
Found 1 items
drwxr-xr-x - navyaannampelly hadoop 0 2022-10-22 09:28 hdfs:///mydata/ml-100k
navyaannampelly@cluster-9185-m:~$


navyaannampelly@cluster-9185-m:~$ pyspark
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[GCC 10.3.0] on linux
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22/10/22 09:30:42 INFO org.apache.spark.SparkEnv: Registering OutputCommitCoordinator
Welcome to
version 3.1.3

```
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 3.1.3
      /_/

Using Scala version 2.12.14 (OpenJDK 64-Bit Server VM, Java 1.8.0_345)
Type in expressions to have them evaluated.
Type :help for more information.

scala> val lines = sc.textFile("hdfs:///mydata/pagerank.txt")
lines: org.apache.spark.rdd.RDD[String] = hdfs:///mydata/pagerank.txt MapPartitionsRDD[1] at textFile at <console>:23

scala> val links = lines.map{ s =>  val parts = s.split("\\s+")
     |  (parts(0), parts(1))
     |  }.distinct().groupByKey().cache()
links: org.apache.spark.rdd.RDD[(String, Iterable[String])] = ShuffledRDD[11] at groupByKey at <console>:25

scala> var ranks = links.mapValues(v=> 1.0)
ranks: org.apache.spark.rdd.RDD[(String, Double)] = MapPartitionsRDD[12] at mapValues at <console>:23

scala> ranks.collect()
res1: Array[(String, Double)] = Array((B,1.0), (A,1.0), (C,1.0))
```

Result

First Iteration

```
scala> for (i <- 1 to 1){
     |    val contribs = links.join(ranks).values.flatMap{case (urls,rank) =>
     |    val size = urls.size
     |    urls.map(url => (url, rank/size))
     |    }
     |    ranks = contribs.reduceByKey(_ + _).mapValues(0.15 + 0.85 * _)
     | }

scala> val result = ranks.collect()
result: Array[(String, Double)] = Array((B,0.575), (A,1.0), (C,1.4249999999999998))
```

Result

Second Iteration

```
      | val size = urls.size
      | urls.map(url => (url, rank/size))
      | }
      | ranks = contribs.reduceByKey(_ + _).mapValues(0.15 + 0.85 * _)
      | }

scala> val result2 = ranks.collect()
result2: Array[(String, Double)] = Array((B,0.7285312499999999), (A,1.0541874999999998), (C,1.2172812499999996))

scala> result2.foreach(tup => println(tup._1 + "has rank: " + tup._2 + "."))
Bhas rank: 0.7285312499999999.
Ahas rank: 1.0541874999999998.
Chas rank: 1.2172812499999996.
```

Result

Third Iteration

```
scala>  for (i <- 1 to 3){
     |     val contribs = links.join(ranks).values.flatMap{case (urls,rank) =>
     |     val size = urls.size
     |      urls.map(url => (url, rank/size))
     | }
     | ranks = contribs.reduceByKey(_ + _).mapValues(0.15 + 0.85 * _)
     | }

scala> val result3 = ranks.collect()
result3: Array[(String, Double)] = Array((B,0.6534928515624998), (A,1.1375453730468745), (C,1.2089617753906245))

scala> result3.foreach(tup => println(tup._1 + "has rank: " + tup._2 + "."))
Bhas rank: 0.6534928515624998.
Ahas rank: 1.1375453730468745.
Chas rank: 1.2089617753906245.
```

Enhancement Ideas

- With n iterations, we may test the pagerank algorithm.
- We can determine the pagerank of large websites with numerous links.

Conclusion

- The PageRank value of a page u is determined by the PageRank values of each page v in the set Bu (the set of all pages connecting to page u), divided by the quantity L(v) of links from page v.

- For the algorithm to calculate the PageRank, a damping factor of 0.85 is used. It is comparable to the income tax that the government withholds from one even if it has already paid him.

References

- http://lintool.github.io/Cloud9/docs/content/pagerank.html
- http://people.revoledu.com/kardi/tutorial/PageRank/index.htm
- http://stat.rutgers.edu/home/tzhang/papers/nips07-ranking.pdf
- https://hc.labnet.sfbu.edu/~henry/npu/classes/mapreduce/week1/syllabus.html


THANK
YOU
Thank you