MIDS-W261-2016-HW-Week05-Lane

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1 DATASCI W261: Machine Learning at Scale

1.1 Assignment Week 5

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2 === Week 5 ASSIGNMENTS ===

2.1 HW 5.0

What is a data warehouse? What is a Star schema? When is it used? HW 5.1 In the database world What is 3NF? Does machine learning use data in 3NF? If so why? In what form does ML consume data? Why would one use log files that are denormalized? –

2.2 HW 5.2

Using MRJob, implement a hashside join (memory-backed map-side) for left, right and inner joins. Run your code on the data used in HW 4.4: (Recall HW 4.4: Find the most frequent visitor of each page using mrjob and the output of 4.2 (i.e., transfromed log file). In this output please include the webpage URL, webpageID and Visitor ID.) :

Justify which table you chose as the Left table in this hashside join.

Please report the number of rows resulting from:

(1) Left joining Table Left with Table Right

(2) Right joining Table Left with Table Right

(3) Inner joining Table Left with Table Right

–

```
In [301]: %%writefile MRJob5_2.py
          #!/usr/bin/python
          from mrjob.job import MRJob, MRStep
          import re

          class MRJob5_2(MRJob):


              def steps(self):
                  return [MRStep(
                          mapper_init = self.mapper_init,
                          mapper = self.mapper,
                          mapper_final = self.mapper_final, jobconf={
```

```
                        'mapreduce.job.maps': '1'
                                })]

    def mapper_init(self):
        self.urls = {}
        self.pages = []
        self.all = 0
        self.rightonly = 0
        self.leftonly = 0
        with open("urls.data") as urls:
            for line in urls.readlines():
                fields = line.strip().split(",")
                self.urls[fields[1]] = "www.microsoft.com" + fields[4].strip().strip('"')


    def mapper(self, _, line):
        line = line.strip()
        line = line.split(",")
        webpageID = line[1]
        visitorID = line[4]
        self.pages.append(webpageID)
        if webpageID in self.urls.keys():
            self.all += 1
            yield "inner",self.urls[webpageID]+","+webpageID+","+visitorID
            yield "left",self.urls[webpageID]+","+webpageID+","+visitorID
            yield "right",self.urls[webpageID]+","+webpageID+","+visitorID
        else:
            self.rightonly += 1
            yield "right","None,"+webpageID+","+visitorID

    def mapper_final(self):
        #Let's now check if there are any pages that never got any visitors, meaning that only
        for webpageID in self.urls.keys():
            if webpageID not in self.pages:
                self.leftonly += 1
                yield "left", self.urls[webpageID]+","+webpageID+",None"
        yield "Number of Left Joins",str(self.all + self.leftonly)
        yield "Number of Inner Joins", str(self.all)
        yield "Number of Right Joins",str(self.all + self.rightonly)

if __name__ == '__main__':
    MRJob5_2.run()
```

```
Overwriting MRJob5_2.py
```

Driver Class

```
In [55]: %reload_ext autoreload
         %autoreload 2

         from MRJob5_2 import MRJob5_2
         mr_job = MRJob5_2(args=['Processed-anonymous-msweb.data','-r','hadoop','--file',"urls.data",'-
         with mr_job.make_runner() as runner:
             runner.run()
             output = open("output.txt","w")
```

```
            for line in runner.stream_output():
                output.write(line)
            output.close()
        !tail -10 output.txt
```

```
"left"        "www.microsoft.com/devmovies,1290,None"
"left"        "www.microsoft.com/news,1291,None"
"left"        "www.microsoft.com/centroam,1297,None"
"left"        "www.microsoft.com/bookshelf,1294,None"
"left"        "www.microsoft.com/autoroute,1287,None"
"left"        "www.microsoft.com/masterchef,1289,None"
"left"        "www.microsoft.com/library,1288,None"
"Number of Left Joins"        "98663"
"Number of Inner Joins"        "98654"
"Number of Right Joins"        "98654"
```

2.3 HW 5.3 EDA of Google n-grams dataset

A large subset of the Google n-grams dataset
https://aws.amazon.com/datasets/google-books-ngrams/
which we have placed in a bucket/folder on Dropbox on s3:
https://www.dropbox.com/sh/tmqpc4o0xswhkvz/AACUifrl6wrMrlK6a3X3lZ9Ea?dl=0
s3://filtered-5grams/
In particular, this bucket contains (~200) files (10Meg each) in the format:

```
(ngram) \t (count) \t (pages_count) \t (books_count)
```

For HW 5.3-5.5, for the Google n-grams dataset unit test and regression test your code using the first 10 lines of the following file:
googlebooks-eng-all-5gram-20090715-0-filtered.txt
Once you are happy with your test results proceed to generating your results on the Google n-grams dataset.
Do some EDA on this dataset using mrjob, e.g.,

- Longest 5-gram (number of characters)
- Top 10 most frequent words (please use the count information), i.e., unigrams
- 20 Most/Least densely appearing words (count/pages_count) sorted in decreasing order of relative frequency
- Distribution of 5-gram sizes (character length). E.g., count (using the count field) up how many times a 5-gram of 50 characters shows up. Plot the data graphically using a histogram.

```
In [333]: %%writefile MRJob5_3.py
          #!/usr/bin/python
          import sys
          from mrjob.job import MRJob, MRStep
          from mrjob.protocol import RawProtocol

          class MRJob5_3(MRJob):

              MRJob.SORT_VALUES = True
              INTERNAL_PROTOCOL = RawProtocol


              def steps(self):
                  return [MRStep(mapper = self.mapper_wordcount, combiner = self.combiner_wordcount, re
```

```
            MRStep(mapper = self.mapper_process, reducer = self.reducer_process, jobconf={
                                    'mapreduce.job.maps': '8',
                'mapreduce.job.reduces': '4',
                        }),
             MRStep(reducer_init = self.reducer_sortreport_init, reducer = self.reducer_so
             jobconf={
                'mapreduce.job.output.key.comparator.class': 'org.apache.hadoop.mapred.li
                'stream.num.map.output.key.field': 3,
                'stream.map.output.field.separator':'\t',
                'mapreduce.partition.keycomparator.options': '-k1,1 -k2,2n',
                      })]

def mapper_wordcount(self, _, line):
        line = line.strip()
        [ngram,count,pages_count,books_count] = line.split("\t")
        count = int(count)
        pages_count = int(pages_count)
        books_count = int(books_count)
        words = ngram.split()
        for word in words:
            yield ngram+","+word, str([count,pages_count,books_count])

def combiner_wordcount(self, key, counts):
    newcount =0
    for line in counts:
        [count,pages_count,books_count] =eval(line)
        newcount += count
    yield key,str([newcount,pages_count,books_count])

def reducer_wordcount(self, key, counts):
    newcount =0
    for line in counts:
        [count,pages_count,books_count] =eval(line)
        newcount += count
    yield key,str([newcount,pages_count,books_count] )

def mapper_process  (self,key,counts):
    ngram, word = key.split(",")
    words_in_ngram = len(ngram.split())
    [count,pages_count,books_count] = eval(counts)
    yield "A: Longest 5-gram\t1", ngram
    yield "B: Top 10 most frequent words," + word+"\t1",str(count)
    yield "C: 20 Most/Least densely appearing words," + word+"\t1",str([count,pages_count
    yield "D: Distribution of 5-gram sizes," + str( len(ngram))+"\t1",str(float(count) / 

def reducer_process(self,key,values):
    keyfields = key.split(",")
    goal = keyfields[0]
    values = map(lambda v: v.split("\t")[1], values)

    if goal == "A: Longest 5-gram":
        ngrams = values
        for ngram in ngrams:
            yield goal, str(-1*len(ngram))+"\t"+ngram
```

```
                elif goal == "B: Top 10 most frequent words":
                    word = keyfields[1]
                    yield goal,str(-1*sum(map(int,values)))+"\t"+word
                elif goal == "C: 20 Most/Least densely appearing words" :
                    word = keyfields[1]
                    count =0
                    pages_count = 0
                    for line in values:
                        [c,p] = eval(line)
                        count+= c
                        pages_count+=p
                    yield "C: 20 least densely appearing words",str(sum([(float(1)*count)/ pages_coun
                    yield "C: 20 most densely appearing words",str(sum([(float(-1)*count)/ pages_coun
                else:
                    gram_length = keyfields[1]
                    yield "D: Distribution of 5-gram sizes",str(sum(map(float,values)))+"\t"+gram_leng

            def reducer_sortreport_init(self):
                self.goal_report_limits = {
                    "A: Longest 5-gram": 1,
                    "B: Top 10 most frequent words": 10,
                    "C: 20 least densely appearing words": 20,
                    "C: 20 most densely appearing words": 20,
                    "D: Distribution of 5-gram sizes": -1
                }

            def reducer_sortreport(self,goal,lines):
                yield "--------","--------"
                yield goal, ":"
                for line in lines:
                    if self.goal_report_limits[goal] == 0: break
                    self.goal_report_limits[goal] = self.goal_report_limits[goal] -1
                    line = line.strip()
                    number_field,category_field = line.split("\t")
                    number_field = float(number_field)
                    if number_field < 0: number_field *= -1
                    yield category_field, str(number_field)

        if __name__ == '__main__':
            MRJob5_3.run()
```

```
Overwriting MRJob5_3.py
```

Unit Test

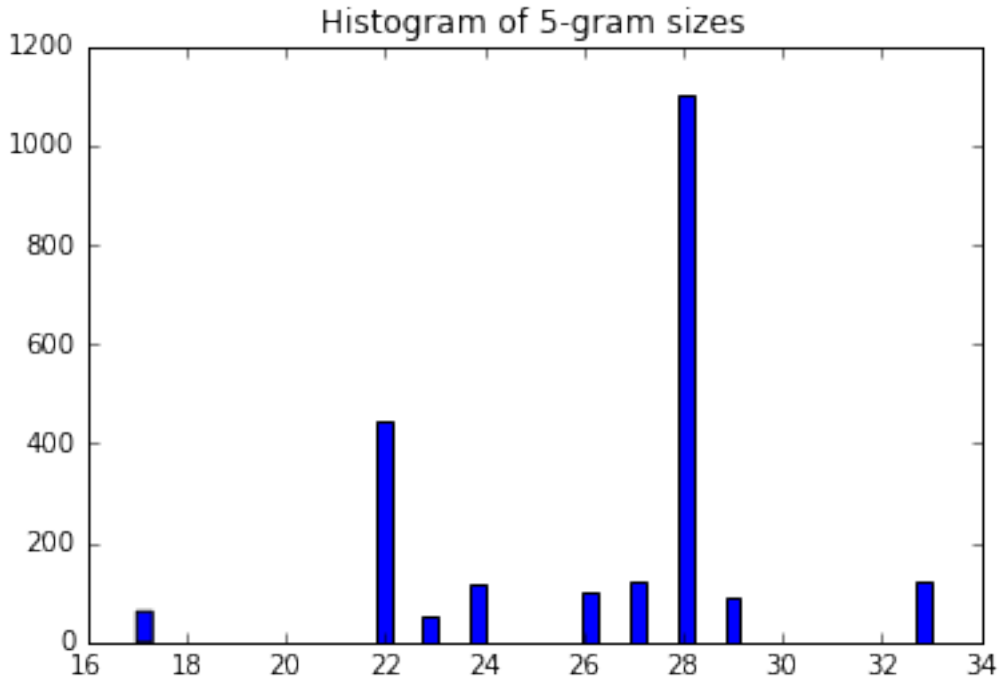
```
In [334]: !head -n 10 filtered-5Grams/googlebooks-eng-all-5gram-20090715-0-filtered.txt > unitTestData
```

```
In [339]: !hdfs dfs -rm -r results/5.3/UnitTest
          !python MRJob5_3.py unitTestData -r hadoop --output-dir ./results/5.3/UnitTest \
          --cleanup=ALL 2>/dev/null >NGramsEDAUnitTest
```

```
16/06/19 15:11:59 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
16/06/19 15:12:00 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion interval = 0 minut
Deleted results/5.3/UnitTest
```

```
In [343]: %matplotlib inline
          %reload_ext autoreload
          %autoreload 2
          distribution = {}
          with open("NGramsEDAUnitTest") as myfile:
              partD = False
              for line in myfile.readlines():
                  line = line.strip().replace('"','')
                  line =  line.split("\t")
                  if (line[0] == "D: Distribution of 5-gram sizes"):
                      partD = True
                      continue
                  if partD:
                      distribution[int(line[0])] = float(line[1])
                  else: print '\t'.join(map(str,line))

          plt.hist(distribution.keys(), weights=distribution.values(), bins=50)
          plt.title("Histogram of 5-gram sizes")
          plt.show()

--------        --------
A: Longest 5-gram        :
A Circumstantial Narrative of the        33.0
--------        --------
B: Top 10 most frequent words        :
A        2217.0
in        1201.0
Christmas        1099.0
Wales        1099.0
Child's        1099.0
of        1011.0
Study        604.0
Case        604.0
Female        447.0
Collection        239.0
--------        --------
C: 20 least densely appearing words        :
Female        1.0
Case        1.0
Limited        1.0
Narrative        1.0
ESTABLISHING        1.0
RELIGIOUS        1.0
Government        1.0
Circumstantial        1.0
FOR        1.0
Study        1.0
BILL        1.0
the        1.01639344262
George        1.02222222222
General        1.02222222222
Biography        1.02222222222
A        1.02829313544
in        1.03267411866
```

```
Sea         1.03333333333
City         1.03333333333
by         1.03333333333
--------         --------
C: 20 most densely appearing words         :
of         1.15675057208
Forms         1.12621359223
Collection         1.08636363636
Fairy         1.05128205128
Tales         1.05128205128
Child's         1.03581526861
Wales         1.03581526861
Christmas         1.03581526861
by         1.03333333333
City         1.03333333333
Sea         1.03333333333
in         1.03267411866
A         1.02829313544
George         1.02222222222
Biography         1.02222222222
General         1.02222222222
the         1.01639344262
Study         1.0
BILL         1.0
FOR         1.0
--------         --------
```



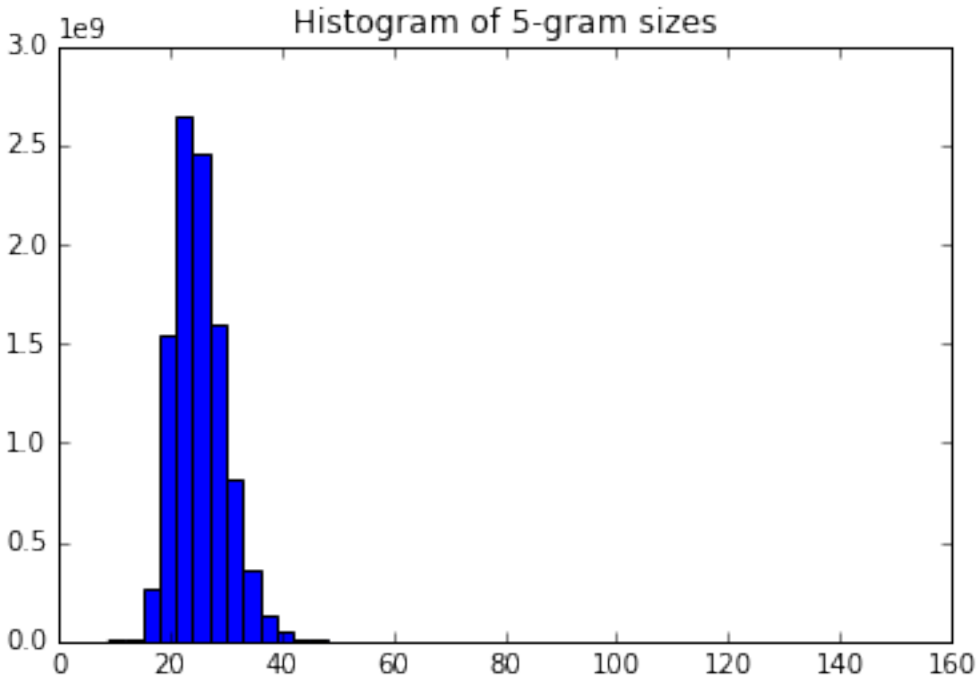

```
In [345]: !hdfs dfs -rm -r results/5.3
          !python MRJob5_3.py filtered-5Grams -r hadoop --output-dir ./results/5.3 \
```

```
          --cleanup=ALL 2>/dev/null >NGramsEDA

16/06/19 15:29:45 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
16/06/19 15:29:46 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion interval = 0 minut
Deleted results/5.3
```

```
In [346]: %matplotlib inline
          %reload_ext autoreload
          %autoreload 2
          distribution = {}
          with open("NGramsEDA") as myfile:
              partD = False
              for line in myfile.readlines():
                  line = line.strip().replace('"','')
                  line =  line.split("\t")
                  if (line[0] == "D: Distribution of 5-gram sizes"):
                      partD = True
                      continue
                  if partD:
                      distribution[int(line[0])] = float(line[1])
                  else: print '\t'.join(map(str,line))

          plt.hist(distribution.keys(), weights=distribution.values(), bins=50)
          plt.title("Histogram of 5-gram sizes")
          plt.show()
```

```
--------        --------
A: Longest 5-gram        :
AIOPJUMRXUYVASLYHYPSIBEMAPODIKR UFRYDIUUOLBIGASUAURUSREXLISNAYE RNOONDQSRUNSUBUNOUGRABBERYAIRTC UTAHRAP
--------        --------
B: Top 10 most frequent words        :
the        5375699242.0
of        3691308874.0
to        2221164346.0
in        1387638591.0
a        1342195425.0
and        1135779433.0
that        798553959.0
is        756296656.0
be        688053106.0
as        481373389.0
--------        --------
C: 20 least densely appearing words        :
Leshchetitsky        1.0
Leshkowich        1.0
Nescit        1.0
Leskov        1.0
Nescio        1.0
Leslea        1.0
Nescience        1.0
Nescia        1.0
Lesley's        1.0
Nescafe        1.0
Leslies        1.0
Nesbitt        1.0
```

```
Lesly        1.0
Nesbit’s        1.0
Lesly’s        1.0
Nesace        1.0
Lesmahago        1.0
Lespinasse        1.0
Lespenard        1.0
AAAA        1.0
--------        --------
C: 20 most densely appearing words        :
xxxx        11.557291666666666
NA        10.161726044782885
blah        8.0741599073001158
nnn        7.5333333333333332
nd        6.5611436445056839
ND        5.4073642846747196
oooooooooooooooo        4.921875
PIC        4.7272727272727275
llll        4.5116279069767442
LUTHER        4.3494983277591972
oooooo        4.2072378595731514
NN        4.0908402725208175
ooooo        3.9492846924177396
OOOOOO        3.9313725490196076
IIII        3.7877030162412995
lillelu        3.7624521072796937
OOOOO        3.6570701447431206
Sc        3.6065624999999999
Pfeffermann        3.5769230769230771
Madarassy        3.5769230769230771
--------        --------
```



HW 5.3.1 OPTIONAL Question: - Plot the log-log plot of the frequency distributuion of unigrams. Does it follow power law distribution?

For more background see: https://en.wikipedia.org/wiki/Log%E2%80%93log_plot https://en.wikipedia.org/wiki/Power_law –

2.4 HW 5.4 Synonym detection over 2Gig of Data

For the remainder of this assignment you will work with two datasets:

2.4.1 1: unit/systems test data set: SYSTEMS TEST DATASET

Three terms, A,B,C and their corresponding strip-docs of co-occurring terms

DocA {X:20, Y:30, Z:5} DocB {X:100, Y:20} DocC {M:5, N:20, Z:5}

2.4.2 2: A large subset of the Google n-grams dataset as was described above

For each HW 5.4 -5.5.1 Please unit test and system test your code with respect to SYSTEMS TEST DATASET and show the results. Please compute the expected answer by hand and show your hand calculations for the SYSTEMS TEST DATASET. Then show the results you get with you system.

In this part of the assignment we will focus on developing methods for detecting synonyms, using the Google 5-grams dataset. To accomplish this you must script two main tasks using MRJob:

(1) Build stripes for the most frequent 10,000 words using cooccurence informationa based on the words ranked from 9001,-10,000 as a basis/vocabulary (drop stopword-like terms), and output to a file in your bucket on s3 (bigram analysis, though the words are non-contiguous).

```
In [388]: import nltk
          from nltk.corpus import stopwords
          nltk.download("stopwords")
          nltk.download("wordnet")

          with open("stopwords","w") as myfile:
              myfile.write(str(stopwords.words('english')))
```

```
[nltk_data] Downloading package stopwords to /home/hadoop/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to /home/hadoop/nltk_data...
[nltk_data]   Unzipping corpora/wordnet.zip.
```

Since the stopwords from seem to all be in lowercase, I'll the ngram words to lowercase as well before checking whether they exist in the stopwords list.

```
In [392]: %%writefile MRJob5_4_wordcount.py
          from mrjob.job import MRJob, MRStep
          from mrjob.protocol import RawProtocol

          class MRJob5_4_wordcount(MRJob):

              MRJob.SORT_VALUES = True
              INTERNAL_PROTOCOL = RawProtocol
              SORT_VALUES = True

              def steps(self):
                  return [MRStep(mapper_init=self.mapper_wordcount_init,mapper = self.mapper_wordcount,
```

```
                                combiner = self.reducer_wordcount, reducer = self.reducer_wordcount),
                            MRStep(reducer = self.reducer_sortreport,
                            jobconf={
                           'mapreduce.job.output.key.comparator.class': 'org.apache.hadoop.mapred.lib.KeyF
                        'stream.num.map.output.key.field': 2,
                        'stream.map.output.field.separator':'\t',
                        'mapreduce.partition.keycomparator.options': '-k2,2nr -k1,1',

                                    })]

            def mapper_wordcount_init(self):
                    with open('stopwords') as myfile:
                        self.stopwords = eval(myfile.readline())

            def mapper_wordcount(self, _, line):
                    line = line.strip()
                    [ngram,count,pages_count,books_count] = line.split("\t")
                    words = ngram.split()
                    for word in words:
                        #Filter out the stop words
                        if word.lower() not in self.stopwords:
                            yield word, count

            def reducer_wordcount(self, key, counts):
                yield key,str(sum(map(int,counts)))

            def reducer_sortreport(self,key,counts):
                      yield key, counts.next()


        if __name__ == '__main__':
            MRJob5_4_wordcount.run()

Overwriting MRJob5_4_wordcount.py

In [408]: %reload_ext autoreload
          %autoreload 2
          !hdfs dfs -rm -r results/5.4/wordcount

          from MRJob5_4_wordcount import MRJob5_4_wordcount
          mr_job = MRJob5_4_wordcount(args=['filtered-5Grams','-r','hadoop',
                                            '--file','stopwords','--output-dir','./results/5.4/wordcount
          with mr_job.make_runner() as runner:
              runner.run()
              output = open("topwords.txt","w")
              for line in runner.stream_output():
                  output.write(line)
              output.close()

16/06/19 18:05:41 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
rm: `results/5.4/wordcount': No such file or directory

In [590]: %%writefile MRJob5_4_cooccurence.py

          from mrjob.job import MRJob, MRStep
```

```
import sys

class MRJob5_4_cooccurence(MRJob):

    MRJob.SORT_VALUES = True

    def steps(self):
           return [  MRStep(mapper_init=self.mapper_coocurrence_init, mapper=self.mapper_cooc
                       , combiner=self.combiner_coocurrence, reducer_init=self.reducer_coocu
                       , reducer=self.reducer_coocurrence, reducer_final=self.reducer_coocur
                       , jobconf={
             'mapreduce.job.maps': '4',
             'mapreduce.job.reduces': '4',
                    }
                      ),
                 MRStep(reducer=self.reducer_sortreport,
                        jobconf={
             'mapreduce.partition.keycomparator.options': '-k1,1'
                    }
                      )
                 ]


    def mapper_coocurrence_init(self):
        with open("topwords.txt") as myfile:
            vocab = []
            for i in range(10000):
                line = myfile.readline().strip()
                word, count = line.split("\t")
                vocab.append(word.strip())
            self.top10k = set(vocab[:10001])
            self.basis =  set(vocab[9001:10001])
            sys.stderr.write(str(self.basis) + "\n")


    def mapper_coocurrence(self, _, line):
        # parse line, get words and counts
        ngram, count, _, _ = line.strip().split('\t')
        words = ngram.split()
        words = list(set(filter(lambda w: w in self.top10k,words)))
        # emit each pair of words (order matters, a word can pair with itself)
        for word1 in words:
            for word2 in words:
                if word2 in self.basis and word2 <> word1:
                    yield (word1,word2),int(count)

    def combiner_coocurrence(self, words, counts):
        yield words, sum(map(int,counts))

    def reducer_coocurrence_init(self):
        self.word = ''
        self.stripe = {}

    def reducer_coocurrence(self, words, counts):
```

```
                newword1, newword2 = words
                if self.word == newword1:
                    self.stripe[newword2] =  self.stripe.setdefault(newword2,0)+ sum(counts)
                else:
                    if len(self.stripe) > 0:
                        yield self.word, self.stripe
                    self.word = newword1
                    self.stripe = {newword2:sum(counts)}


            def reducer_coocurrence_final(self):
                if len(self.stripe) > 0:
                    yield self.word, self.stripe

            def reducer_sortreport(self,word,dicts):
                result = {}
                for d in dicts:
                    result.update(d)

                yield word+"."+str(len(result)), result


        if __name__ == '__main__':
            MRJob5_4_cooccurence.run()
```

```
Overwriting MRJob5_4_cooccurence.py
```

(2) Using two (symmetric) comparison methods of your choice (e.g., correlations, distances, similarities), pairwise compare all stripes (vectors), and output to a file in your bucket on s3.

```
In [591]: %%writefile MRJob5_4_jaccard.py
          from mrjob.job import MRJob
          from mrjob.step import MRStep

          import sys
          class MRJob5_4_jaccard(MRJob):
              MRJob.SORT_VALUES = True
              def steps(self):
                  return [MRStep(mapper=self.mapper_pairintersections , reducer=self.reducer_pairinters
                                 {
                      'mapreduce.partition.keypartitioner.options': '-k1,1',
                      'mapreduce.partition.keycomparator.options': '-k2,2',
                      'mapreduce.job.reduces': '4',
                      'stream.num.map.output.key.fields': '2',
                          }),
                         MRStep(reducer_init=self.reducer_jaccard_init , reducer=self.reducer_jaccard)
                         ]

              def mapper_pairintersections(self, _, line):
                  word0, stripe = line.split("\t")
                  stripe = eval(stripe).keys()
                  for i,word1 in enumerate(stripe):
                      yield ("*",word1),1
                      for word2 in stripe[i+1:]:
                          yield (word1,word2), 1
```

```
            def reducer_pairintersections(self,key,counts):
                sys.stderr.write(str(key) + "\n")
                yield key,sum(map(int,counts))

            def reducer_jaccard_init(self):
                self.lengths={}

            def reducer_jaccard(self, words, values):
                word1,word2 = map(str,words)
                if word1 == "*":
                    self.lengths[word2]=sum(map(int,values))
                else:
                    intersection = sum(map(float,values))
                    jaccard = intersection / (self.lengths[word1] + self.lengths[word2] - intersectio
                    yield (word1,word2), jaccard

        if __name__ == '__main__':
            MRJob5_4_jaccard.run()
```

```
Overwriting MRJob5_4_jaccard.py
```

First let's run unit test

```
In [586]: %%writefile SystemTestData
          advisory bedside        50        50        50
          bedside Cathedral disciplines        10        10        10
          advisory disciplines        15        15        15
```

```
Overwriting SystemTestData
```

```
In [ ]: !hdfs dfs -rm -r results/5.4/UnitTest/co-occurence
        !python MRJob5_4_cooccurence.py SystemTestData -r hadoop --file topwords.txt  --output-dir ./res
        --cleanup=ALL 2>/dev/null >cooccurenceUnitTest
        !head -25 cooccurenceUnitTest
```

```
In [589]: !hdfs dfs -rm -r results/5.4/UnitTest/jaccard
          !python MRJob5_4_jaccard.py cooccurenceUnitTest -r hadoop  --output-dir ./results/5.4/UnitTes
          --cleanup=ALL 2>/dev/null | head -25
```

```
16/06/21 01:51:20 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
16/06/21 01:51:21 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion interval = 0 minut
Deleted results/5.4/UnitTest/jaccard
["Cathedral", "bedside"]        0.25
["advisory", "disciplines"]        0.25
["bedside", "disciplines"]        0.5
```

Now run on NGram dataset

```
In [ ]: !hdfs dfs -rm -r results/5.4/co-occurence
        !python MRJob5_4_cooccurence.py filtered-5Grams -r hadoop --file topwords.txt --output-dir ./res
        --cleanup=ALL 2> /dev/null > cooccurence
        !head -3 cooccurence
```

```
16/06/21 01:54:16 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform...
rm: 'results/5.4/co-occurence': No such file or directory
```

```
In [ ]: !hdfs dfs -rm -r results/5.4/jaccard
        !python MRJob5_4_jaccard.py 'cooccurence'  -r hadoop --output-dir ./results/5.4/jaccard \
        --cleanup=ALL 2>/dev/null > 'jaccard'
        !head -25 jaccard
```

==Design notes for (1)== For this task you will be able to modify the pattern we used in HW 3.2 (feel free to use the solution as reference). To total the word counts across the 5-grams, output the support from the mappers using the total order inversion pattern:

<*word,count>

to ensure that the support arrives before the cooccurrences.

In addition to ensuring the determination of the total word counts, the mapper must also output co-occurrence counts for the pairs of words inside of each 5-gram. Treat these words as a basket, as we have in HW 3, but count all stripes or pairs in both orders, i.e., count both orderings: (word1,word2), and (word2,word1), to preserve symmetry in our output for (2).

==Design notes for (2)== For this task you will have to determine a method of comparison. Here are a few that you might consider:

- Jaccard
- Cosine similarity
- Spearman correlation
- Euclidean distance
- Taxicab (Manhattan) distance
- Shortest path graph distance (a graph, because our data is symmetric!)
- Pearson correlation
- Kendall correlation ...

However, be cautioned that some comparison methods are more difficult to parallelize than others, and do not perform more associations than is necessary, since your choice of association will be symmetric.

Please use the inverted index (discussed in live session #5) based pattern to compute the pairwise (term-by-term) similarity matrix.

Please report the size of the cluster used and the amount of time it takes to run for the index construction task and for the synonym calculation task. How many pairs need to be processed (HINT: use the posting list length to calculate directly)? Report your Cluster configuration!

```
In [ ]:
```

2.4.3 HW 5.5

Evaluation of synonyms that your discovered In this part of the assignment you will evaluate the success of you synonym detector (developed in response to HW5.4). Take the top 1,000 closest/most similar/correlative pairs of words as determined by your measure in HW5.4, and use the synonyms function in the accompanying python code:

nltk_synonyms.py

Note: This will require installing the python nltk package:

http://www.nltk.org/install.html

and downloading its data with nltk.download().

For each (word1,word2) pair, check to see if word1 is in the list, synonyms(word2), and vice-versa. If one of the two is a synonym of the other, then consider this pair a 'hit', and then report the precision, recall, and F1 measure of your detector across your 1,000 best guesses. Report the macro averages of these measures.

```
In [385]: #!/usr/bin/python2.7
          ''' pass a string to this funciton ( eg 'car') and it will give you a list of
          words which is related to cat, called lemma of CAT. '''
          import nltk
          from nltk.corpus import wordnet as wn
```

```
import sys
import numpy as np
#print all the synset element of an element
def synonyms(string):
    syndict = {}
    for i,j in enumerate(wn.synsets(string)):
        syns = j.lemma_names()
        for syn in syns:
            syndict.setdefault(syn,1)
    return syndict.keys()
```

```
In [389]: synonyms("AB")
```

```
Out[389]: [u'Bachelor_of_Arts',
 u'abdominal',
 u'BA',
 u'type_AB',
 u'AB',
 u'Artium_Baccalaurens',
 u'group_AB',
 u'Av',
 u'abdominal_muscle',
 u'ab',
 u'Ab']
```

HW5.6 Optional

Repeat HW5 using vocabulary words ranked from 8001,-10,000; 7001,-10,000; 6001,-10,000; 5001,-10,000; 3001,-10,000; and 1001,-10,000; Dont forget to report you Cluster configuration.

Generate the following graphs: – vocabulary size (X-Axis) versus CPU time for indexing – vocabulary size (X-Axis) versus number of pairs processed – vocabulary size (X-Axis) versus F1 measure, Precision, Recall

–

HW 5.7 (optional) There is also a corpus of stopwords, that is, high-frequency words like "the", "to" and "also" that we sometimes want to filter out of a document before further processing. Stopwords usually have little lexical content, and their presence in a text fails to distinguish it from other texts. Python's nltk comes with a prebuilt list of stopwords (see below). Using this stopword list filter out these tokens from your analysis and rerun the experiments in 5.5 and disucuss the results of using a stopword list and without using a stopword list.

> from nltk.corpus import stopwords > stopwords.words('english') ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his', 'himself', 'she', 'her', 'hers', 'herself', 'it', 'its', 'itself', 'they', 'them', 'their', 'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', 'these', 'those', 'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having', 'do', 'does', 'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', 'while', 'of', 'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during', 'before', 'after', 'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under', 'again', 'further', 'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each', 'few', 'more', 'most', 'other', 'some', 'such', 'no', 'nor', 'not', 'only', 'own', 'same', 'so', 'than', 'too', 'very', 's', 't', 'can', 'will', 'just', 'don', 'should', 'now']

HW 5.6 (optional) There are many good ways to build our synonym detectors, so for optional homework, measure co-occurrence by (left/right/all) consecutive words only, or make stripes according to word co-occurrences with the accompanying 2-, 3-, or 4-grams (note here that your output will no longer be interpretable as a network) inside of the 5-grams. –

Hw 5.7 (optional) Once again, benchmark your top 10,000 associations (as in 5.5), this time for your results from 5.6. Has your detector improved?

–

========== END OF ASSIGNMENT #5 ==========