Distributed Data Analytics
Exercise 06 – Group 2
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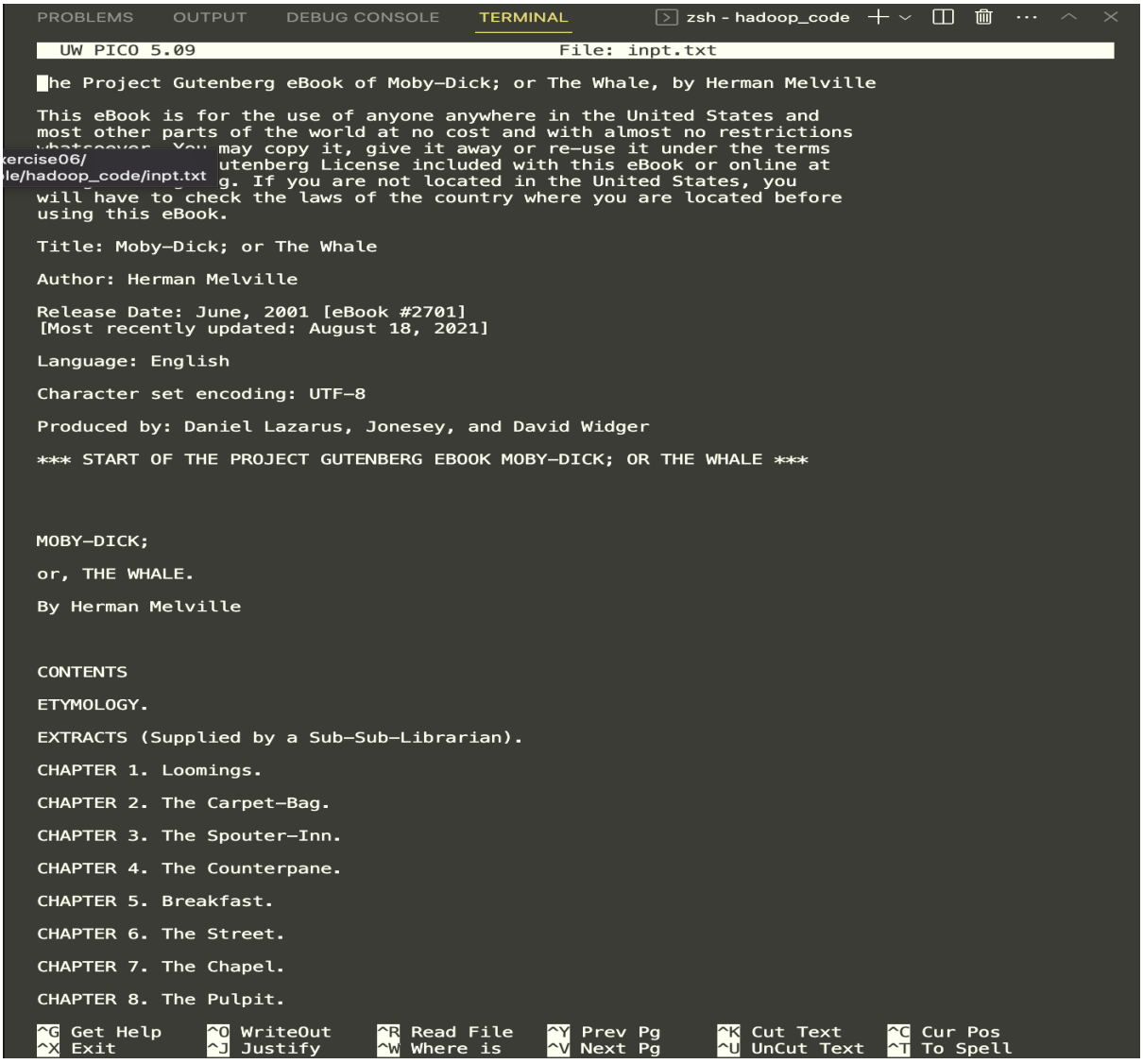
1. Setup

Download the plain text version of Moby Dick from here: https://www.gutenberg.org/files/2701/2701-0.txt and store it as input file for your MapReduce program.



Prepare a list of punctuations and a list of stop words for the English language (you can use one from online, or create one yourself)

To capture all punctuation marks and separate them from words and numbers, I used regular expressions '**pattern='\W'**'. this will match all characters that are not letters or digits.
I found stop words online and here is my stopwords:

```
stopwords = [
   "a", "an", "and", "as", "at", "be", "by", "for", "from", "has", "he", "in", "is",
   "it", "its", "of", "on", "that", "the", "to", "was", "were", "with", "I", "you",
   "your", "we", "they", "his", "her", "him", "she", "me", "myself", "ourselves",
```

```
    "them", "themselves", "ours", "our", "who", "what", "where", "when", "why", "how",
    "which", "there", "here"
]
```

2. Word importance with text rank

Write a MapReduce program that archives the following things:

1. Remove punctuation and stopwords from the text.

Mapper.py:

```
import re
import sys

stopwords = [
    "a", "an", "and", "as", "at", "be", "by", "for", "from", "has", "he", "in",
"is",
    "it", "its", "of", "on", "that", "the", "to", "was", "were", "with", "I",
"you",
    "your", "we", "they", "his", "her", "him", "she", "me", "myself", "ourselves",
    "them", "themselves", "ours", "our", "who", "what", "where", "when", "why",
"how",
    "which", "there", "here"
]

for line in sys.stdin:
    line = line.strip()
    line = line.lower()
    line = re.sub(pattern='\W', repl=' ', string=line)
    line = re.sub(pattern='\s+', repl=' ', string=line)
    words = line.split()
    filteredWords = [word for word in words if word not in stopwords]
    line = ' '.join(filteredWords)
    print(line)
```

This code converts input text to lowercase, removes punctuation marks and white spaces from input.txt file using regular expressions, filter out stop words from the text and joins the filtered text.

Reducer.py:

```
import sys
for line in sys.stdin:
    line = line.strip()
    print(line)
```

The reducer code reads the output from the mapper, remove any trailing white space and prints the line.

2. Count the number of ”links” for each target word as defined by the Text Rank algorithm.

Mapper.py

```
import re
import sys
from collections import defaultdict

stopwords = [
    "a", "an", "and", "as", "at", "be", "by", "for", "from", "has", "he", "in",
"is",
    "it", "its", "of", "on", "that", "the", "to", "was", "were", "with", "I",
"you",
    "your", "we", "they", "his", "her", "him", "she", "me", "myself", "ourselves",
    "them", "themselves", "ours", "our", "who", "what", "where", "when", "why",
"how",
    "which", "there", "here"
]

linksCount = defaultdict(set)
for line in sys.stdin:
    line = line.strip()
    line = line.lower()
    line = re.sub(pattern='\W', repl=' ', string=line)
    line = re.sub(pattern='\s+', repl=' ', string=line)
    words = line.split()
    filteredWords = [word for word in words if word not in stopwords]
    line= ' '.join(filteredWords)

    if not line:
        continue

    tokens = line.split()
    numTokens = len(tokens)
    for i in range(numTokens):
        Word = tokens[i]
        linksCount[Word].update(tokens[j] for j in range(i+1, numTokens))

for Word in linksCount:
    numLinks = len(linksCount[Word])
    print(f'{Word}\t{numLinks}')
```

Reducer.py

```
import sys

linkCounter = 0

for line in sys.stdin:
    linkCounter += 1
print(f'Number of links: {linkCounter}')
```

output

```
2023-06-01 13:31:51 INFO  StreamJob:1029 - Output directory: out
Number of links: 17589
[root@377eb2826715 code]#
```

3. Display every word with a number of links above a threshold of 100.

Reducer.py:

```
import sys
treshold = 100
linkCounter = 0

for line in sys.stdin:
    word, count = line.strip().split('\t')
    count = int(count)
    if count > treshold:
        print(f'{word}\t{count}')
```

we will define threshold and initialize it to 100 and then do a check if the count is greater than threshold, we display the word with its count.

output

```
2023-06-01 13:45:05 INFO  StreamJob:1029 - Output directory: out
1       122
about   654
above   158
aft     119
after   605
again   538
against 354
ago     107
ahab    944
air     380
all     2487
almost  462
aloft   174
alone   114
along   271
already 110
also    271
always  205
am      265
american        109
among   400
another 326
any     780
anything        125
are     1278
arm     202
arms    108
art     143
aspect  126
away    386
aye     349
back    368
bear    108
because 253
bed     208
been    857
before  651
began   131
behind  156
being   565
below   148
beneath 237
besides 149
best    181
better  174
between 291
bildad  224
bit     105
black   271
blood   172
blubber 103
blue    130
board   179
boat    680
boats   385
body    288
bone    148
bones   138
book    182
```

Examine the output and iterate a couple of times by extending your list of stopwords and adjusting the threshold until you see meaningful words that seem important for this story.

4. Extending text rank

Extend your Text Rank algorithm by allowing bigger tuples of words.

Mapper.py

```
import re
import sys
from collections import defaultdict

stopwords = [
    "a", "an", "and", "as", "at", "be", "by", "for", "from", "has", "he", "in",
"is",
    "it", "its", "of", "on", "that", "the", "to", "was", "were", "with", "I",
"you",
    "your", "we", "they", "his", "her", "him", "she", "me", "myself", "ourselves",
    "them", "themselves", "ours", "our", "who", "what", "where", "when", "why",
"how",
    "which", "there", "here"
]

linksCount = defaultdict(set)
for line in sys.stdin:
    line = line.strip()
    line = line.lower()
    line = re.sub(pattern='\W', repl=' ', string=line)
    line = re.sub(pattern='\s+', repl=' ', string=line)
    words = line.split()
    filteredWords = [word for word in words if word not in stopwords]
    line= ' '.join(filteredWords)

    if not line:
        continue

    tokens = line.split()
    for n in range(1, len(tokens) + 1):
        numTokens = len(tokens)
        for i in range(numTokens - n + 1):
            wordTuple = tuple(tokens[i:i+n])
            Word = wordTuple[0]
            linksCount[Word].update(wordTuple[1:])

for Word in linksCount:
    numLinks = len(linksCount[Word])
    print(f'{Word}\t{numLinks}')
```

Provide a qualitative analysis of different sizes of tuples and how that affects the important words.

Different sizes of tuples will impact the importance of word in the output. For example, having a tuple of one word, the output will be independent words without relation to other words. Having a tuple of 2 words means we will be looking at the relations of the words and we can get another broader meaning of the phrase.

5. Engineering task*

Write a second MapReduce program that uses the output of Text Rank and sorts the generated tuples by number of links.
The mapper and reducer will be very simple. The main task is to engineer a bash script that executes the two MapReduce jobs sequentially and use that script inside the Docker Image.

Secondmapper.py

```
import sys

BLUE = '\033[34m'
RESET_COLOR = '\033[0m'

for line in sys.stdin:
    line = line.strip()
    words, numLinks = line.split('\t')
    numLinks = int(numLinks)
    colored_words = f'{BLUE}{words}{RESET_COLOR}'
    print(f'{numLinks}\t{colored_words}')
```

secondreducer.py

```
import sys

tuples = []
for line in sys.stdin:
    line = line.strip()
    numLinks, words = line.split('\t')
    try:
        numLinks = int(numLinks)
        tuples.append((numLinks, words))
    except ValueError:
        continue
#sort tuples by numLinks
sortedTuples = sorted(tuples)
for numLinks, words in sortedTuples:
    print(f'{words}\t{numLinks}')
```

modified run.sh file

```
rm -r out
rm -r sorted_out
rm -r hdfs
mkdir hdfs
```

```
hdfs dfs -put inpt.txt hdfs/inpt.txt
hadoop jar /opt/hadoop/share/hadoop/tools/lib/hadoop-streaming-3.3.5.jar \
    -files mapper.py \
    -mapper "python3 mapper.py" \
    -file reducer.py \
    -reducer "python3 reducer.py" \
    -input hdfs/inpt.txt \
    -output out
cat out/part-00000

hadoop jar /opt/hadoop/share/hadoop/tools/lib/hadoop-streaming-3.3.5.jar \
    -files secondmapper.py \
    -mapper "python3 secondmapper.py" \
    -file secondreducer.py \
    -reducer "python3 secondreducer.py" \
    -input out/part-00000 \
    -output sorted_out | awk '{print "\033[0;32m" $0 "\033[0m"}'

#cat sorted_out/part-00000
echo "First 10 lines:"
head -n 10 sorted_out/part-00000
echo "Last 10 lines:"
tail -n 10 sorted_out/part-00000
```

output

```
2023-06-02 11:45:33 INFO  StreamJob:1029 - Output directory: sorted_out
First 10 lines:
bound   101
fear    101
held    101
ho      101
ice     101
none    101
pole    101
sideways        101
sky     101
start   101
Last 10 lines:
now     1601
one     1603
so      1788
whale   1832
not     1850
this    2369
i       2469
all     2487
but     2710
s       2739
[root@377eb2826715 code]#
```

I have come up with a second MapReduce program that takes the output of the first program which is performing text rank as input and sorts the generated number of links in an

ascending order. It then gives an output of the first 10 and the last 10 number of links when sorted. This is just to illustrate the achievement of sorting in ascending order.
I also modified the run file (run.sh) to enable the 2 MapReduce programs to run concurrently.