**CSI 611 Big Data Assignment 2**

# Programming Assignment: Joining Data using MapReduce

In this assignment, you are given a Python mapper and reducer to perform the Join Data. The purpose of Part 1 of this assignment is to provide an example for Part 2. In Part 2 you will need to modify the provided Python code (or write your own) to perform a different Join and upload the output file(s).

### **PART 1**

1. Follow the steps from the Wordcount assignment to set up the following files on Cloudera: join1\_mapper.py, join1\_reducer.py, join1\_FileA.txt, and join1\_FileB.txt (see the Code and Text Files section at the bottom)

Don’t forget to enter the following at the unix prompt to make it executable

> chmod +x join1\_mapper.py

> chmod +x join1\_reducer.py

2. Follow the steps from the Wordcount assignment to set up the data in HDFS

3. Test the program in serial execution using the following Unix utilities and piping commands:

(‘cat’ prints out the text files standard output; ‘|’ pipes the standard output to the standard input of the join\_mapper program, etc.. )

> cat join1\_File\*.txt | ./join1\_mapper.py | sort | ./join1\_reducer.py

To debug programs in serial execution one should use small datasets and possibly extra print statements in the program. Debugging with map/reduce jobs is harder but hopefully not necessary for this assignment. There are more descriptions of how to debug your code in the lab files

4. Run the Hadoop streaming command:

(Note that your file paths may differ. Note the ‘\’ just means the command continues on next line. )

> hadoop jar /usr/lib/hadoop-mapreduce/hadoop-streaming.jar \

   -input /user/cloudera/assign2 \

   -output /user/cloudera/output\_join \

   -mapper /home/cloudera/join1\_mapper.py \

   -reducer /home/cloudera/join1\_reducer.py

### **PART 2: A new join problem**

1. First generate some datasets using the scripts (see the Code and Text Files section at the bottom) as follows:

> sh make\_data\_join2.txt

(this is a script that produces 6 files:

python make\_join2data.py y 1000 13 > join2\_gennumA.txt

python make\_join2data.py y 2000 17 > join2\_gennumB.txt

…)

2. Use HDFS commands to copy the 6 files created in step 1 into one HDFS directory, just like step 2 in Part 1 and in the wordcount assignment.

Note: These datasets are pseudo-randomly generated so the output is the same for any environment. The files are not large, however they are big enough that it would be time consuming to solving the assignment by hand. One could put the data in a database but that would defeat the purpose of the assignment!

3. The datasets generated in step 1 contain the following information:

join2\_gennum\*.txt consist of <TV show, count> (A TV show title and the number of viewers)

Example join2\_gennum\*.txt:

Almost\_News, 25

Hourly\_Show,30

Hot\_Cooking,7

Almost\_News, 35

Postmodern\_Family,8

Baked\_News,15

Dumb\_Games,60

…

join2\_genchan\*.txt consists of <TV show title, channel> (A TV show title and the channel it was on)

Example join2\_genchan\*.txt:

Almost\_News, ABC

Hourly\_Show, COM

Hot\_Cooking, FNT

Postmodern\_Family, NBC

Baked\_News, FNT

Dumb\_Games, ABC

…

4. Your Task: Implement the following join request in Map/Reduce:

### **What is the total number of viewers for shows on ABC?**

The show-to-channel relationship is Many-to-Many. In other words, each show might appear on many channels, and each channel might broadcast many shows.

In pseudo-SQL it might be something like:

select sum( viewer count) from File A, File B where FileA.TV show = FileB.TV show and FileB.Channel='ABC' grouped by TV show

5. Upload the resulting output from the reducers, use numReduceTasks=1

The output will look like: <TVshow\_title total\_viewers>

Example Output:

Almost\_News 60

Dumb\_Games 60

\_

### **Data Notes:**

* TV show titles do not have spaces
* Channels have 3 letters
* TV show titles can appear multiple times, with different counts
* A TV show and channel combination might appear multiple times
* TV shows could appear on multiple channels
* The output should have no commas or punctuation, only 1 space between the TV show title and number

### **Programming Notes and Detailed Suggestions:**

You should be able to use 1 map/reduce job. If you are not a programmer, then you should review the join1 code and the wordcount code. You should consider starting with the join1\_mapper and the join1\_reducer code. I believe all the logic and functional examples you will need are in the wordcount and the join1 code.

**Hint 1**: The new join mapper is like the join1 mapper but instead of stripping dates from the key field it should be selecting rows related to 'ABC'.

In Python strings are character arrays. Strings can be declared and accessed as follows:

my\_string = 'LMNOP'

my\_string[0:3]='LMN'

In Python the string function to check if a string is just digits is as follows:

my\_string.isdigit() # will return True or False.

**Hint 2**: The new join reducer is like the join1\_reducer but instead of building up a list of dates & counts, it should be summing viewer counts to keep a running total. Make sure you understand what will be in the intermediate output files that become reducer input (after the mapper and after Hadoop shuffle & group). Look carefully at the groups that are present in the reducer input to see what conditions your reducer will have to check for. You can test the mapper output using the Unix piping mentioned in Part 1.

**Hint 3**: This new join task has some overlap with wordcounting task. Use the wordcount code to review the counting and updating logic, as well as functions that handle strings and integers.

**Hint 4**: Here is a possible pseudo code example of how to implement this join using tv-show as the key:

**join2\_mapper**:

read lines, and split lines into key & value

if value is ABC or if value is a digit print it out

Note: you can test just the mapper by running something like:

> cat join2\_gen\*.txt | ./join2\_mapper.py | sort

Also, if we did have huge files partitioned across a cluster you might have information about viewer counts in one partition and information about which show is on ABC in another partition. The mapper and the Hadoop shuffle will bring those bits of information together to the same reducer if a key is a show.

**join2\_reducer**:

read lines and split lines into key & value

if a key has changed (and it's not the first input)

then check if ABC had been found and print out key and running total,

if value is ABC then set some variable to mark that ABC was found (like abc\_found = True)

otherwise keep a running total of viewer counts

**Hint 5**:

The first two lines of your output should be:

Almost\_Games 49237

Almost\_News 46592

### **Code and Text Files**

join1\_mapper.py

#!/usr/bin/env python

import sys

# --------------------------------------------------------------------------

#This mapper code will input a <date word, value> input file, and move date into

# the value field for output

#

# Note, this program is written in a simple style and does not full advantage of Python

# data structures,but I believe it is more readable

#

# Note, there is NO error checking of the input, it is assumed to be correct

# meaning no extra spaces, missing inputs or counts,etc..

#

# See # see https://docs.python.org/2/tutorial/index.html for details and python tutorials

#

# --------------------------------------------------------------------------

for line in sys.stdin:

line = line.strip() #strip out carriage return

key\_value = line.split(",") #split line, into key and value, returns a list

key\_in = key\_value[0].split(" ") #key is first item in list

value\_in = key\_value[1] #value is 2nd item

#print key\_in

if len(key\_in)>=2: #if this entry has <date word> in key

date = key\_in[0] #now get date from key field

word = key\_in[1]

value\_out = date+" "+value\_in #concatenate date, blank, and value\_in

print( '%s\t%s' % (word, value\_out) ) #print a string, tab, and string

else: #key is only <word> so just pass it through

print( '%s\t%s' % (key\_in[0], value\_in) ) #print a string tab and string

#Note that Hadoop expects a tab to separate key value

#but this program assumes the input file has a ',' separating key value

join1\_reducer.py

#!/usr/bin/env python

import sys

# --------------------------------------------------------------------------

#This reducer code will input a <word, value> input file, and join words together

# Note the input will come as a group of lines with same word (ie the key)

# As it reads words it will hold on to the value field

#

# It will keep track of current word and previous word, if word changes

# then it will perform the 'join' on the set of held values by merely printing out

# the word and values. In other words, there is no need to explicitly match keys b/c

# Hadoop has already put them sequentially in the input

#

# At the end it will perform the last join

#

#

# Note, there is NO error checking of the input, it is assumed to be correct, meaning

# it has word with correct and matching entries, no extra spaces, etc.

#

# see https://docs.python.org/2/tutorial/index.html for python tutorials

#

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# --------------------------------------------------------------------------

prev\_word = " " #initialize previous word to blank string

months = ['Jan','Feb','Mar','Apr','Jun','Jul','Aug','Sep','Nov','Dec']

dates\_to\_output = [] #an empty list to hold dates for a given word

day\_cnts\_to\_output = [] #an empty list of day counts for a given word

# see https://docs.python.org/2/tutorial/datastructures.html for list details

line\_cnt = 0 #count input lines

for line in sys.stdin:

line = line.strip() #strip out carriage return

key\_value = line.split('\t') #split line, into key and value, returns a list

line\_cnt = line\_cnt+1

#note: for simple debugging use print statements, ie:

curr\_word = key\_value[0] #key is first item in list, indexed by 0

value\_in = key\_value[1] #value is 2nd item

#-----------------------------------------------------

# Check if its a new word and not the first line

# (b/c for the first line the previous word is not applicable)

# if so then print out list of dates and counts

#----------------------------------------------------

if curr\_word != prev\_word:

# -----------------------

#now write out the join result, but not for the first line input

# -----------------------

if line\_cnt>1:

for i in range(len(dates\_to\_output)): #loop thru dates, indexes start at 0

print('{0} {1} {2} {3}'.format(dates\_to\_output[i],prev\_word,day\_cnts\_to\_output[i],curr\_word\_total\_cnt))

#now reset lists

dates\_to\_output =[]

day\_cnts\_to\_output=[]

prev\_word =curr\_word #set up previous word for the next set of input lines

# ---------------------------------------------------------------

#whether or not the join result was written out,

# now process the curr word

#determine if its from file <word, total-count> or < word, date day-count>

# and build up list of dates, day counts, and the 1 total count

# ---------------------------------------------------------------

if (value\_in[0:3] in months):

date\_day =value\_in.split() #split the value field into a date and day-cnt

#add date to lists of the value fields we are building

dates\_to\_output.append(date\_day[0])

day\_cnts\_to\_output.append(date\_day[1])

else:

curr\_word\_total\_cnt = value\_in #if the value field was just the total count then its

#the first (and only) item in this list

# ---------------------------------------------------------------

#now write out the LAST join result

# ---------------------------------------------------------------

for i in range(len(dates\_to\_output)): #loop thru dates, indexes start at 0

print('{0} {1} {2} {3}'.format(dates\_to\_output[i],prev\_word,day\_cnts\_to\_output[i],curr\_word\_total\_cnt))

join1\_FileA.txt

able,991

about,11

burger,15

actor,22

join1\_FileB.txt

Feb-02 about,3

Mar-03 about,8

Apr-04 able,13

Feb-22 actor,3

Feb-23 burger,5

Mar-08 burger,2

Dec-15 able,100

make\_join2data.py

#!/usr/bin/env python

import sys

# --------------------------------------------------------------------------

# (make\_join2data.py) Generate a random combination of titles and viewer counts, or channels

# this is a simple version of a congruential generator,

# not a great random generator but enough

# --------------------------------------------------------------------------

chans = ['ABC','DEF','CNO','NOX','YES','CAB','BAT','MAN','ZOO','XYZ','BOB']

sh1 =['Hot','Almost','Hourly','PostModern','Baked','Dumb','Cold','Surreal','Loud']

sh2 =['News','Show','Cooking','Sports','Games','Talking','Talking']

vwr =range(17,1053)

chvnm=sys.argv[1] #get number argument, if its n, do numbers not channels,

lch=len(chans)

lsh1=len(sh1)

lsh2=len(sh2)

lvwr=len(vwr)

ci=1

s1=2

s2=3

vwi=4

ri=int(sys.argv[3])

for i in range(0,int(sys.argv[2])): #arg 2 is the number of lines to output

if chvnm=='n': #no numuber

print('{0}\_{1},{2}'.format(sh1[s1],sh2[s2],chans[ci]))

else:

print('{0}\_{1},{2}'.format(sh1[s1],sh2[s2],vwr[vwi]))

ci=(5\*ci+ri) % lch

s1=(4\*s1+ri) % lsh1

s2=(3\*s1+ri+i) % lsh2

vwi=(2\*vwi+ri+i) % lvwr

if (vwi==4): vwi=5

...

make\_data\_join2.txt (a short command line script)

python make\_join2data.py y 1000 13 > join2\_gennumA.txt

python make\_join2data.py y 2000 17 > join2\_gennumB.txt

python make\_join2data.py y 3000 19 > join2\_gennumC.txt

python make\_join2data.py n 100  23 > join2\_genchanA.txt

python make\_join2data.py n 200  19 > join2\_genchanB.txt

python make\_join2data.py n 300  37 > join2\_genchanC.txt

### **For submission:**

### **In each step, take a screen shot of your terminal and add it to this file after each step.**

### **Provide the complete python code for the missing parts.**

### **Provide the final output “**total viewer counts for TV shows that ABC presents?”

### **Explain the benefits of joining data in big data?**

1. **Add everything in a single pdf file called “ID\_FIRSTNAME\_LASTNAME.pdf”**