Lab 02: MapReduce Programming

CSC14118 Introduction to Big Data 20KHMT1

All in

2023-04-11

Contents

- Author: [All in] group
- Date: 11/04/2023
- Subtitle: CSC14118 Introduction to Big Data 20KHMT1
- Language: English

Task progression

No. of task	% completed
1 - 9	100%
10	30%

1 Problem 1: Word Count

Input: text file 'word_count.txt'

Output: the word count of particular words in the input file: the result as key-value pairs where the key represents the distinct words and the value denotes the number of times the word appears.

Idea: For each word, the mapper function extracts the token and emits a key-value pair where the key is the word and value is set to 1. The reducer reads through the values associated with each key, sums up these values to find the total count for the given word, and emits the final key-value pair representing the word and its respective count.

Code: ***Mapper*** *map() function*:

- Use `toString()` to convert it to a string format that StringTokenizer can work with.
- Each key is a distinct word extracted from the input data, and the value is an integer representation of the number 1 (one), write down (key-value) pairs to `context`.

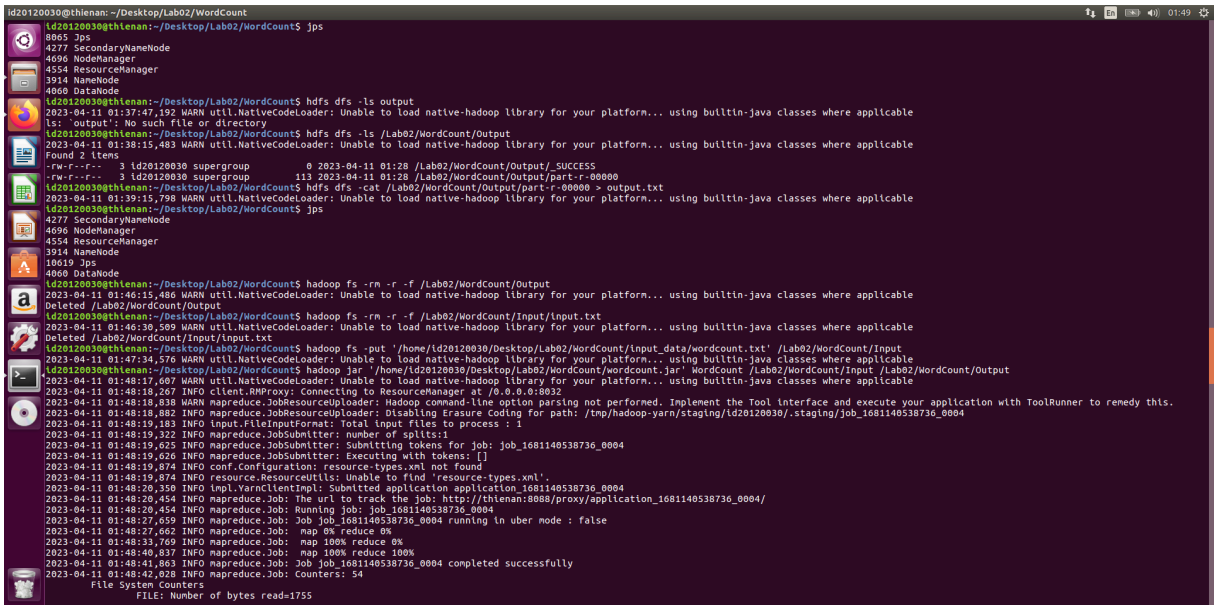
```
StringTokenizer str = new StringTokenizer(value.toString());
while (str.hasMoreTokens()) {
    word.set(str.nextToken());
    context.write(word, one);
}
```

reducer() function: - Iinitializing an integer variable called sum to 0, in order to keep track of the total number of times the given word appears across all the input files. - Iterating over all the values associated with a given key: For each iteration, this line adds the integer value of the current val object to the sum variable. This effectively aggregates the frequency counts assigned to each instance of the word, giving a total count for the entire input data set.

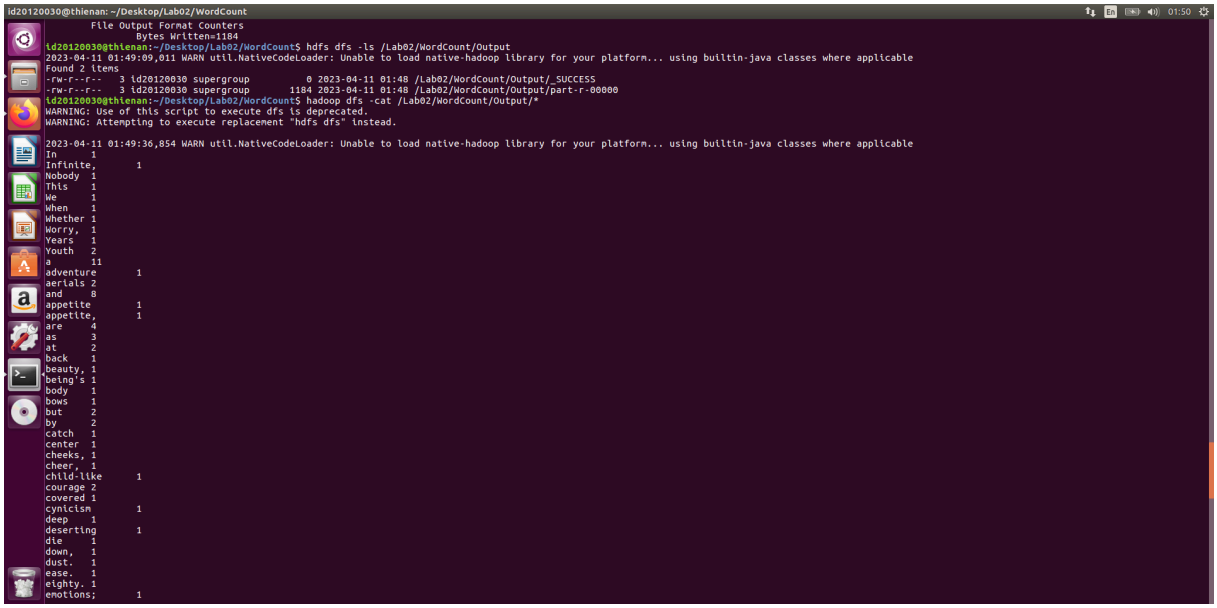
```
int sum = 0;
for (IntWritable val : values) {
    sum += val.get();
}
result.set(sum); // thiết lập giá trị của result thành sum
context.write(key, result);
```

Run program

Run:



Result:



2 Problem 2: Word Size Word Count

Input: a text file name "alphabets" contains a large amount of words from a book.

Output: list of word size and the number of occurences for each word size. In short, how many words has size x, for $x = 1, \dots, \inf$

Idea: this is just some derivation from trivial Word Count program. But here for each word in the text, we have to count the lenght of that word. The key is the word size, and the value is 1 for each word has that size. Using MapReduce mechanism, we then merge the result of each word size to get the final result.

Code:

Mapper The map implementation is `WordSizeWordCountMapper()`. It receives each line of the text, as type `Text`. After that it emits a pair, with key is an integer show the word size - type `IntWritable` - and value is `1`. It means that, the map function seperate words by whitespace, then for each word, it counts the number of letters in that word. At the end, it just found 1 word has some specific size, and it emits them a pair key-value described above.

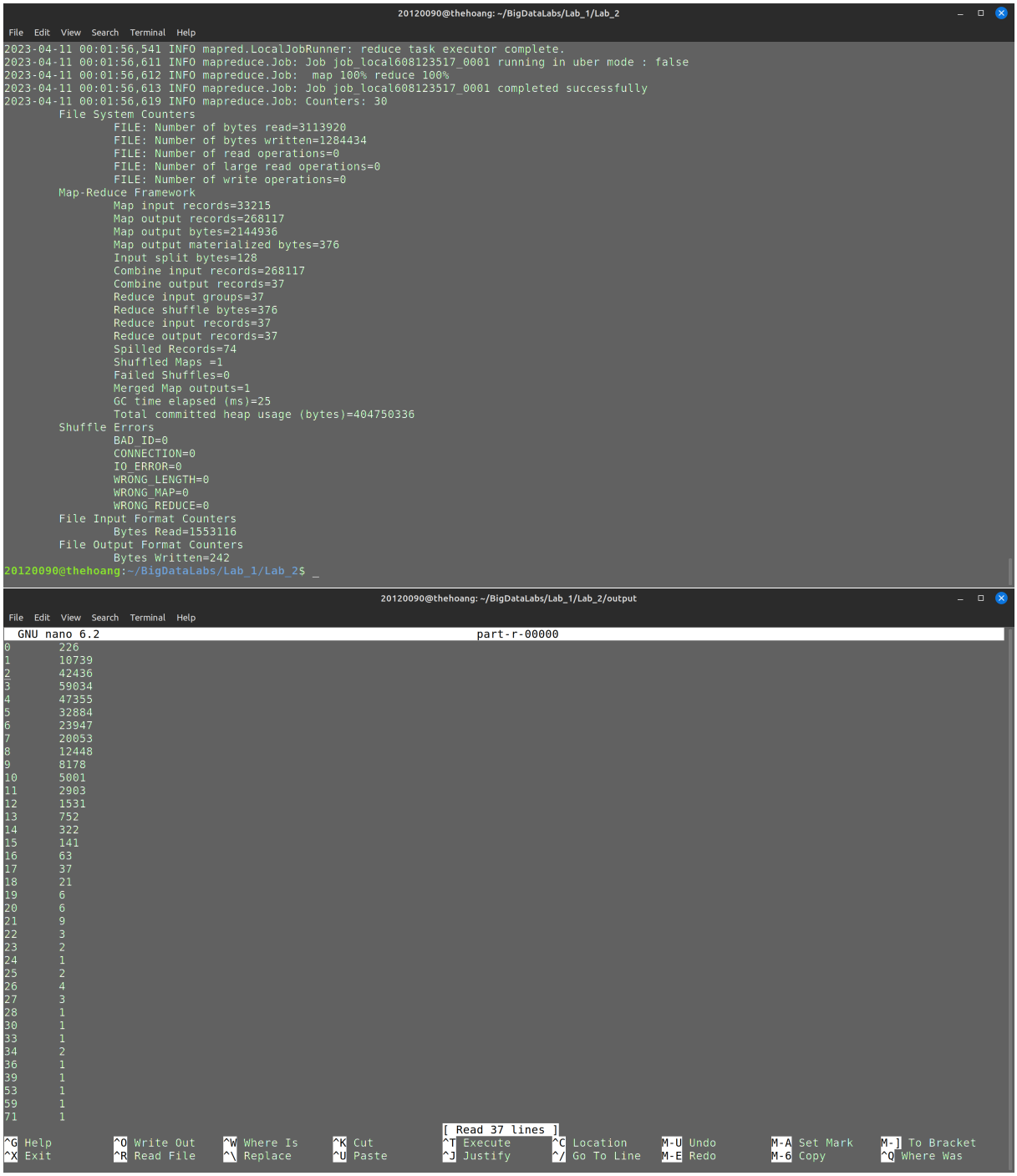
But the word can have some special character as a result of sentence or paragraph. Example `you.`, `ha!`, `so,` have `.`, `!` and `,` attached ti them, but normally, that can not be counted as some valid letter forms a word. To solve this problem in the map function, for each word we only keep `a-zA-Z_` letter and remove all others before we find the size of a word by using Regex [1].

```
word.set( itr.nextToken().replaceAll("[^\\w]", "") );
```

Reducer The reduce implementation is `WordSizeWordCountReducer()`. It receives a pair `<size_of_word, [list_of_1]>` from the map functions. It means it takes one word size and list of 1s respect to how many words have that size. Now the reduce function only need to traverse the list of values and aggregate them. Finally, for each word size, the reduce emits a pair, with key is word size, and with value is the number of occurences, with type `<IntWritable, IntWritable>`.

[1] A. Batkin, "Converting a sentence string to a string array of words in Java," StackOverflow, 2014. https://stackoverflow.com/a/4674887/11985028.

```java
int sum = 0;
for (IntWritable val : values) {
    sum += val.get();
}
result.set(sum);
```



3 Problem 3: Weather Data

Input: data list including date, minimum temperature, maximum temperature and other information

Output: print “hot day” for days with the highest temperature greater than 40 degrees, and “cold days” for days with the lowest temperature less than 10 degrees.

Idea: extract information like date, minimum temperature, maximum temperature. Check for the day has the highest temperature > 40 degrees, the lowest temperature < 10 degrees, then save the date information.

Code:

Mapper *map() function*

- Use the substring() command to get the date and temperature information
- Convert the temperature from string to real number, check the min and max temperature according to the problem requirements and write the result to the context variable.
- Use 2 if functions to check in case a day has minimum temperature less than 10 and maximum temperature greater than 40.

```
Text date = new Text();
Text word = new Text();

String line = value.toString();
String d = line.substring(6, 14);
float max = Float.parseFloat(line.substring(39, 46).trim());
float min = Float.parseFloat(line.substring(47, 53).trim());

if (max > 40.0) {
    date.set(d);
    word.set("Hot day");
    context.write(date, word);
}

if (min < 10.0) {
    date.set(d);
    word.set("Cold day");
    context.write(date, word);
}
```

Reducer *reduce() function*

- Record the output results, if there is a case in the same day that the lowest and highest temperatures are satisfied, then combine “cold day” and “hot day” into 1 result

```
Text result = new Text();
String res = "";
for (Text val : values) {
    res = res + val + " ";
}
result.set(res);
context.write(key, result);
```

4 Problem 4: Patent Program

Input: Each patent has sub-patent ids associated with it.

Output: The number of sub-patent associated with each patent.

Idea: Just look like WordCount program.

Map: Split lines, get 2 tokens and write them to context.

```
public void map(LongWritable key, Text value, Context context) throws IOException,
 ↪  InterruptedException {
            String line = value.toString();
            StringTokenizer tokenizer = new StringTokenizer(line, " ");
            while (tokenizer.hasMoreTokens()) {
                String pat = tokenizer.nextToken();
                k.set(pat);
                String sub = tokenizer.nextToken();
                v.set(sub);
                context.write(k, v);
            }
        }
```

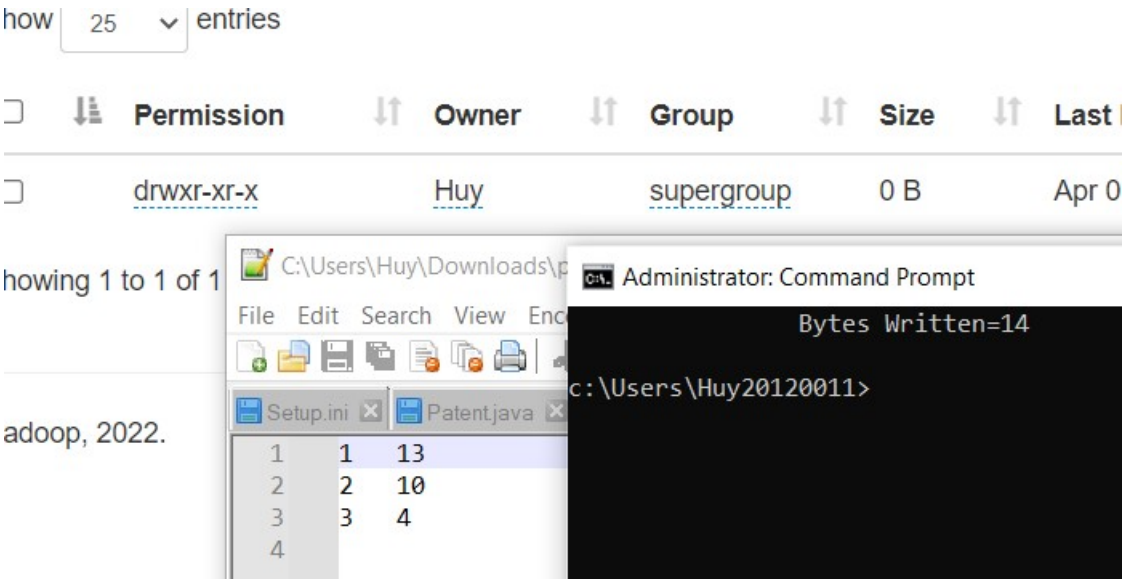
Reduce: Count the number of sub-patent associated with each patent.

```
public void reduce(Text key, Iterable<Text> values, Context context) throws IOException,
 ↪  InterruptedException {
            int sum = 0;
            for (Text x : values) {
                sum++;
            }
            context.write(key, new IntWritable(sum));
        }
```

Run:

```
c:\Users\Huy20120011>hadoop jar D:\HomeWork\Problem4\pt.jar Patent /input/patent.txt /output/patent.txt
2023-04-05 19:13:11,394 INFO client.DefaultNoHARMFailoverProxyProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-04-05 19:13:11,652 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement
```

Result:


how 25 entries
Permission
Owner
Group
Size
Last
drwxr-xr-x
Huy
supergroup
0 B
Apr 0
howing 1 to 1 of 1
adoop, 2022.
C:\Users\Huy\Downloads\p
File Edit Search View Enc
Setup.ini
Patent.java
1 1 13
2 2 10
3 3 4
4
Administrator: Command Prompt
Bytes Written=14
c:\Users\Huy20120011>

5 Problem 5: MaxTemp Program

Input: a subset of temperature records written in text file 'temperature.txt. Each line is a year and a temperature record associated with it. Each year has multiple temperatures listed.

Output: find the maximum temperature during a year. Each line is a year and the maximum temperature record associated with it.

Idea: From the `LabRequirement.pdf`: tokenizes the input data and outputs key-value pairs where the key is the year and the value is the corresponding temperature. The reducer takes these key-value pairs and aggregates them for each year, finding the maximum temperature for each year as it iterates through the values associated with each key.

Code: ***Mapper*** *map() function*:

- Use `toString()` to convert input to a string format that StringTokenizer can work with.
- Breaking each record according to the delimiter whitespace
- For each iteration: set the value for `year` from the first token, and set the value for `temp` from the second one. After that, we convert `temp` (string type) into `temper` (integer type).
- Each key is a distinct year extracted from the input data, and the value is an integer representation of temperature, write down (key-value) pairs to `context`.

```
String line = value.toString();
StringTokenizer tokenizer = new StringTokenizer(line, " ");

while (tokenizer.hasMoreTokens()) {
    String year = tokenizer.nextToken();
    word.set(year);

    String temp = tokenizer.nextToken().trim();
    int temper = Integer.parseInt(temp);
    context.write(word, new IntWritable(temper));
}
```

reducer() function: - Iinitializing an integer variable called `maxtemp` to 0, in order to keep track of the maximum temperature of each year appears across all the input files. - Iterating over all the values associated with a given key: For each iteration, we define a local variable '`temperature` of type

int which is taking all the temperature that belong to that year. Then we compare each element in `temperature` with `maxtemp` to update `maxtemp` with the new value greater than it.

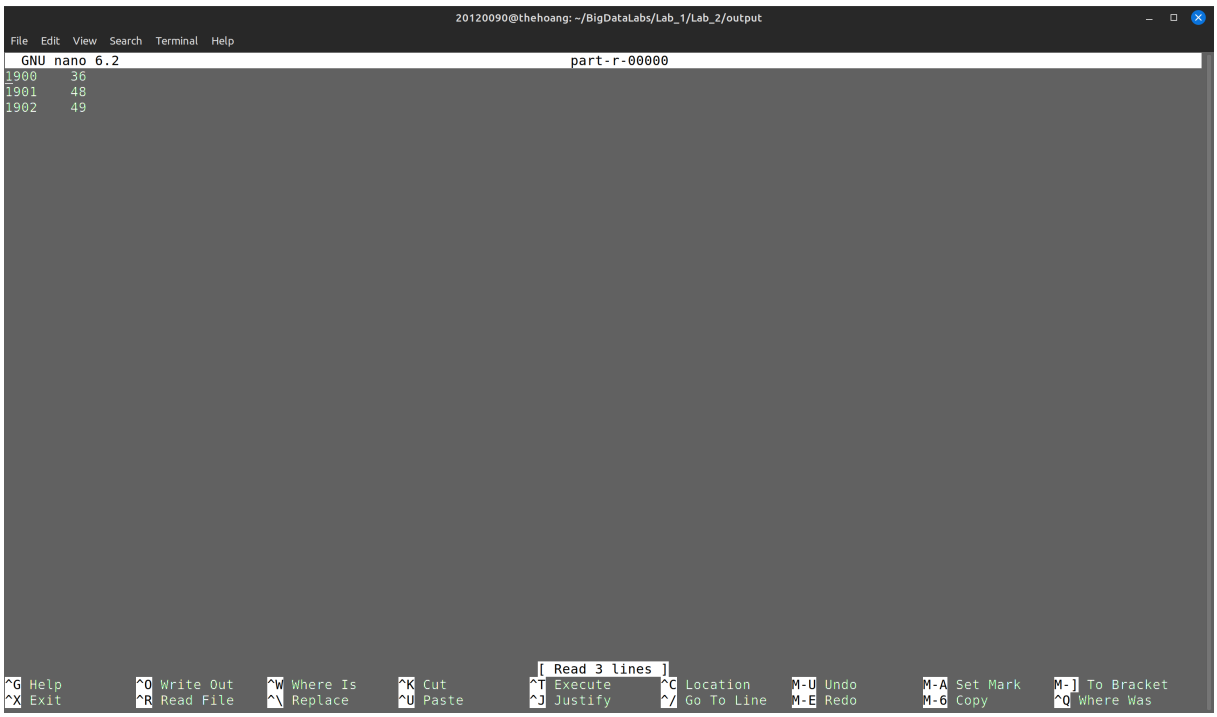
```
int maxtemp = 0;
for(IntWritable it : values) {
    int temperature = it.get();
    if(maxtemp < temperature) {
        maxtemp = temperature;
    }
}

context.write(key, new IntWritable(maxtemp));
```

Run program

Run:

```
20120090@thehoang: ~/BigDataLabs/Lab_1/Lab_2
File  Edit  View  Search  Terminal  Help
2023-04-11 09:21:35,208 INFO mapred.LocalJobRunner: Finishing task: attempt_local1708748547_0001_r_000000_0
2023-04-11 09:21:35,208 INFO mapred.LocalJobRunner: reduce task executor complete.
2023-04-11 09:21:35,837 INFO mapreduce.Job: Job job_local1708748547_0001 running in uber mode : false
2023-04-11 09:21:35,838 INFO mapreduce.Job:  map 100% reduce 100%
2023-04-11 09:21:35,838 INFO mapreduce.Job: Job job_local1708748547_0001 completed successfully
2023-04-11 09:21:35,845 INFO mapreduce.Job: Counters: 30
        File System Counters
                FILE: Number of bytes read=6984
                FILE: Number of bytes written=1288029
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
        Map-Reduce Framework
                Map input records=13
                Map output records=13
                Map output bytes=117
                Map output materialized bytes=149
                Input split bytes=128
                Combine input records=0
                Combine output records=0
                Reduce input groups=3
                Reduce shuffle bytes=149
                Reduce input records=13
                Reduce output records=3
                Spilled Records=26
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=4
                Total committed heap usage (bytes)=394264576
        Shuffle Errors
                BAD_ID=0
                CONNECTION=0
                IO_ERROR=0
                WRONG_LENGTH=0
                WRONG_MAP=0
                WRONG_REDUCE=0
        File Input Format Counters
                Bytes Read=103
        File Output Format Counters
                Bytes Written=36
20120090@thehoang:~/BigDataLabs/Lab_1/Lab_2$ _
```

Result:


20120090@thehoang: ~/BigDataLabs/Lab_1/Lab_2/output
File Edit View Search Terminal Help
GNU nano 6.2 part-r-00000
1900 36
1901 48
1902 49
[Read 3 lines]
^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location M-U Undo M-A Set Mark M-] To Bracket
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line M-E Redo M-6 Copy ^Q Where Was

6 Problem 6: Average Salary Program

Input: the input file is taken from [1]. The file is written in `csv` format, with using `""` as escaped characted for `,` in case of long string. There are 13 fields. In 13 fields, there are 3 empty fields. Based on `id` field, there are 148654 distinct employeees. For this task, we take into account 2 fields: `JobTitle` and `TotalPayBenefits`. We will count for each distinct `JobTitle`, what is the average total pay benefits the employees in that job title can receive. Based on data, there are 2159 distinct `JobTitle`.

Output: for each `JobTitle`, employees in that field receive how much total pay benefits (salary) in average.

Idea: for each `JobTitle`, we only need to take all total pay benefits of all people working in that job title, and create a pair key-value. After that, for each `JobTitle`, we calculate the average values.

Code:

Mapper The map implementation is `AverageSalaryMapper()`. The map function takes each line as input with `Text` type. It then uses seperate the data as csv format by this statements, using Regex (we need to take care the case there is `,` in the job title, so we used Regex). [2].

```
String[] columns = valueStr.split(",(?=(?:[^\"]*\"[^\"]*\")*[^\"]*$)", -1);
```

The map function then just emit the pair `<Text, FloatWritable>` takes from sepetated data. The key is the `JobTitle` and the value is `TotalPayBenefits` of an employee. Here the value of salary is float number, so we use `FloatWritable` for that data.

But because the first line of file contains the header title of the data, we need to use `try...catch...` to preven the case the text are converted to float number.

```
try {
    context.write( new Text(columns[2]), new FloatWritable(Float.parseFloat(columns[8])) );
} catch (Exception e) {
```

[1] A. Batkin, "Converting a sentence string to a string array of words in Java," StackOverflow, 2014. https://stackoverflow.com/a/4674887/11985028.

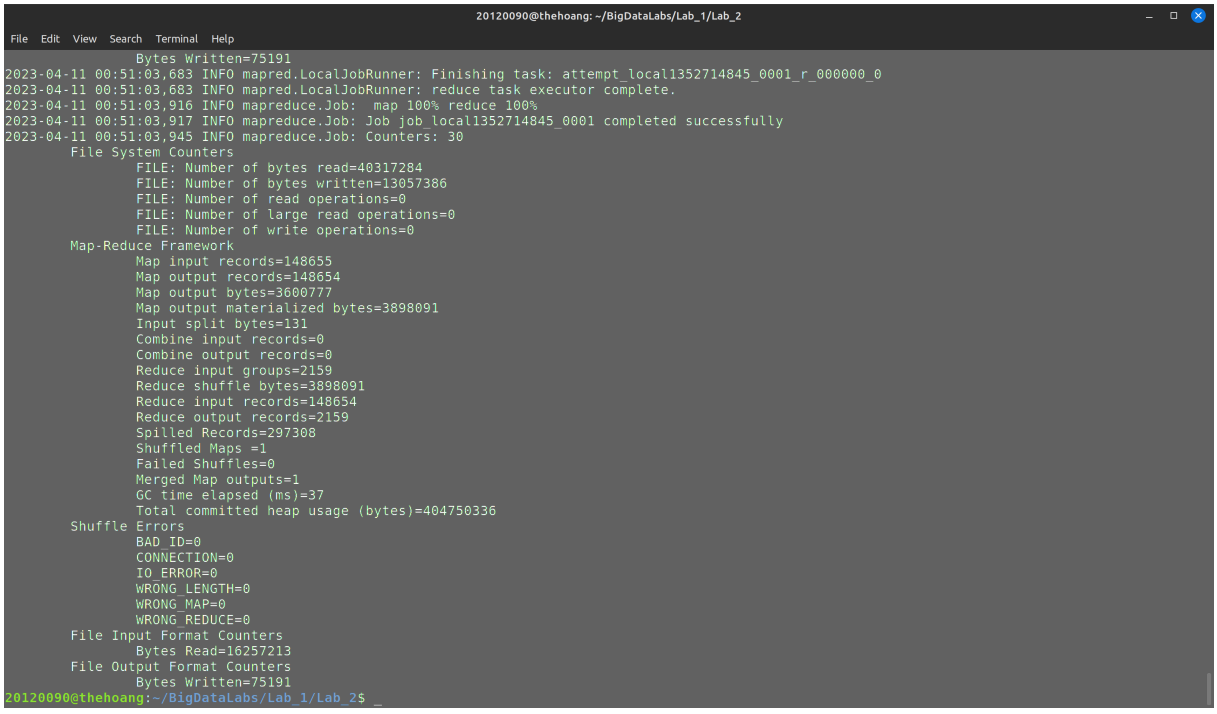
[2] Baeldung, "Ignoring Commas in Quotes When Splitting a Comma-separated String," 2021. https://www.baeldung.com/java-split-string-commas.

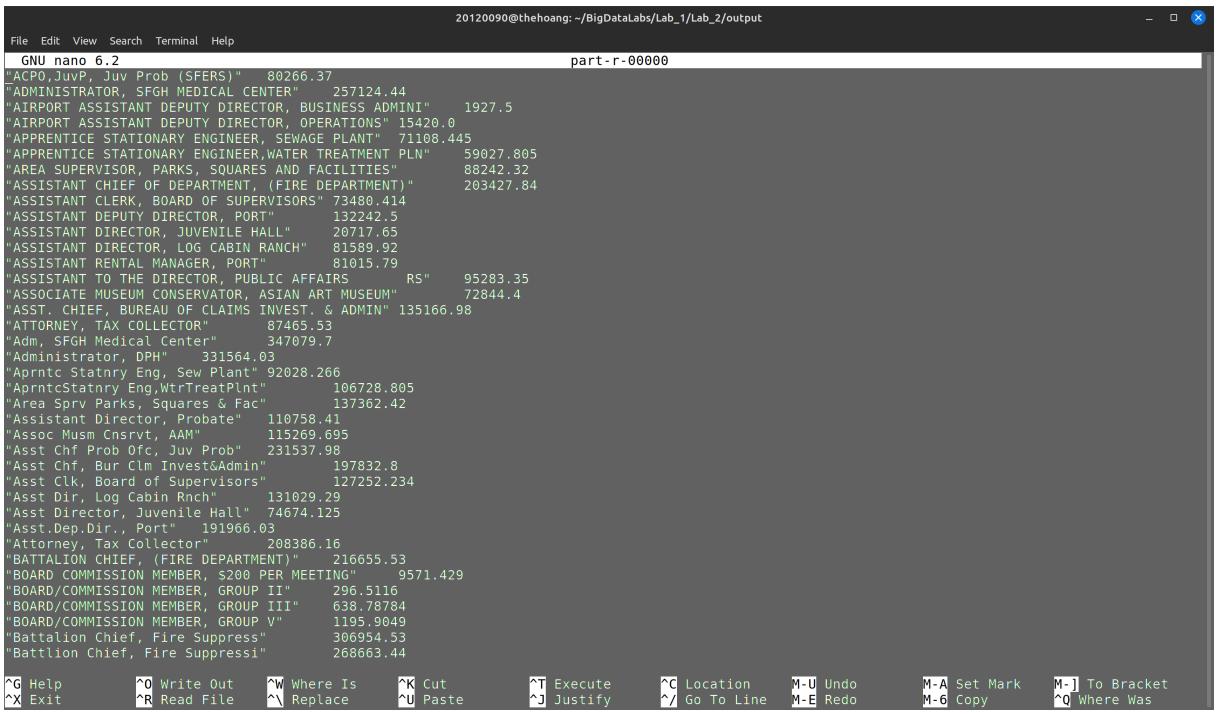
```
    return;
}
```

Reducer The reduce implementation is `AverageSalaryReducer()`. It receives pairs <`JobTitle`, [`list_of_salary_values`]>. It means it takes a job title and list of salary values of all people working in that position. Here we only need to traverse the list of values, then add that value to the current computed average salary value. The detailed implemention is shown below:

```
float average = 0;
int cnt = 0;

for (FloatWritable val : values) {
    ++cnt;
    average = average + (val.get() - average)/cnt;
}
```

It emits the results as <`JobTitle`, `Average_value_computed_of_that_jobtitle`> as type <`Text`, `FloatWritable`>.




20120090@thehoang: ~/BigDataLabs/Lab_1/Lab_2/output
File Edit View Search Terminal Help
GNU nano 6.2 part-r-00000
"ACPO,JuvP, Juv Prob (SFERS)" 80266.37
"ADMINISTRATOR, SFGH MEDICAL CENTER" 257124.44
"AIRPORT ASSISTANT DEPUTY DIRECTOR, BUSINESS ADMINI" 1927.5
"AIRPORT ASSISTANT DEPUTY DIRECTOR, OPERATIONS" 15420.0
"APPRENTICE STATIONARY ENGINEER, SEWAGE PLANT" 71108.445
"APPRENTICE STATIONARY ENGINEER,WATER TREATMENT PLN" 59027.805
"AREA SUPERVISOR, PARKS, SQUARES AND FACILITIES" 88242.32
"ASSISTANT CHIEF OF DEPARTMENT, (FIRE DEPARTMENT)" 203427.84
"ASSISTANT CLERK, BOARD OF SUPERVISORS" 73480.414
"ASSISTANT DEPUTY DIRECTOR, PORT" 132242.5
"ASSISTANT DIRECTOR, JUVENILE HALL" 20717.65
"ASSISTANT DIRECTOR, LOG CABIN RANCH" 81589.92
"ASSISTANT RENTAL MANAGER, PORT" 81015.79
"ASSISTANT TO THE DIRECTOR, PUBLIC AFFAIRS RS" 95283.35
"ASSOCIATE MUSEUM CONSERVATOR, ASIAN ART MUSEUM" 72844.4
"ASST. CHIEF, BUREAU OF CLAIMS INVEST. & ADMIN" 135166.98
"ATTORNEY, TAX COLLECTOR" 87465.53
"Adm, SFGH Medical Center" 347079.7
"Administrator, DPH" 331564.03
"Aprntc Statnry Eng, Sew Plant" 92028.266
"AprntcStatnry Eng,WtrTreatPlnt" 106728.805
"Area Sprv Parks, Squares & Fac" 137362.42
"Assistant Director, Probate" 110758.41
"Assoc Musm Cnsrvt, AAM" 115269.695
"Asst Chf Prob Ofc, Juv Prob" 231537.98
"Asst Chf, Bur Clm Invest&Admin" 197832.8
"Asst Clk, Board of Supervisors" 127252.234
"Asst Dir, Log Cabin Rnch" 131029.29
"Asst Director, Juvenile Hall" 74674.125
"Asst.Dep.Dir., Port" 191966.03
"Attorney, Tax Collector" 208386.16
"BATTALION CHIEF, (FIRE DEPARTMENT)" 216655.53
"BOARD COMMISSION MEMBER, $200 PER MEETING" 9571.429
"BOARD/COMMISSION MEMBER, GROUP II" 296.5116
"BOARD/COMMISSION MEMBER, GROUP III" 638.78784
"BOARD/COMMISSION MEMBER, GROUP V" 1195.9049
"Battalion Chief, Fire Suppress" 306954.53
"Battlion Chief, Fire Suppressi" 268663.44
^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location M-U Undo M-A Set Mark M-] To Bracket
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line M-E Redo M-6 Copy ^Q Where Was

7 Problem 7: DeIdentify Healthcare Program

Input: the input file is described in the given document [1]. We only create the dataset includes 6 records, which are same as in the above document.

Output: we specify the fields we want to encrypt. Here we only keep the 1st, 7th and 9th fields. The others will be encrypted by the SHA-256 encryption algorithm. The final datas need to have the same format as original file.

Idea: we only use one map function to encrypt required fields. The results from this function will also be the final result. We need to choose the field for encryption carefully while keep other fields untouched. The whole idea is taken from [2].

Code:

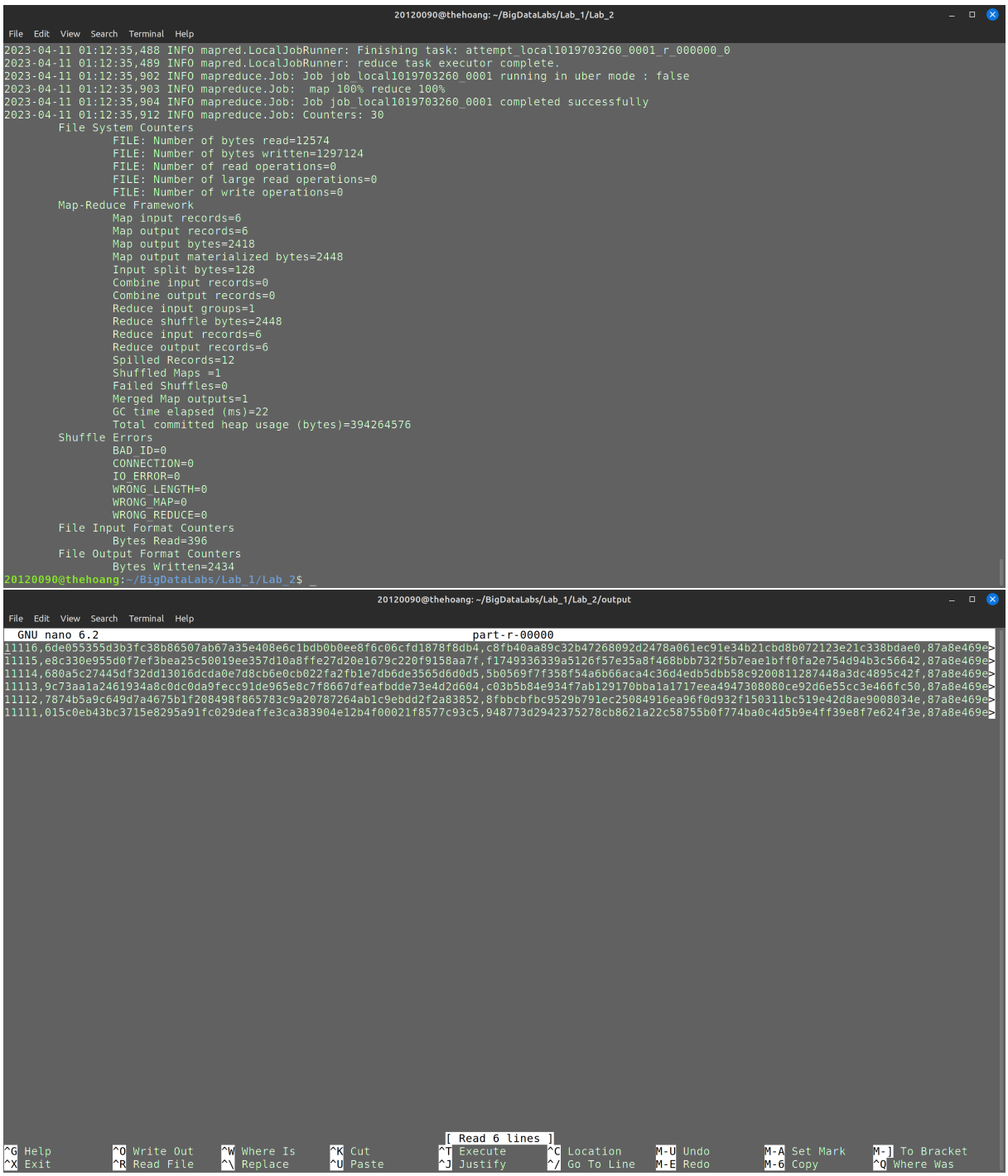
Mapper The map implementation is `DeIdentifyHealthcareMapper`. The map function takes each line as `Text` type, seperate words by `,` deliminiter. There is no special things here, we check if current field need to be encrypted. If it is, we call `toHexString()` and `getSHA()` function to encrypt data as SHA-256 implementation.

We need to take care that, if we have not any result word yet, we must not add `,` to the result word to keep the original data format.

```
if (newStr.length() > 0) newStr += ",";
...
if (newStr.length() > 0) newStr += ",";
```

The map function after encrypted a line of data will emit the pair result as <`null`, `encrypted_text`>. Here, we do not need any key so we set it `null`, the value is the encrypted text.

[1] S. Balasubramanian, "Hadoop-MapReduce Lab." p. 27, 2016.
[2] S. Balasubramanian, "Hadoop-MapReduce Lab." p. 27, 2016.


20120090@thehoang: ~/BigDataLabs/Lab_1/Lab_2
File Edit View Search Terminal Help
2023-04-11 01:12:35,488 INFO mapred.LocalJobRunner: Finishing task: attempt_local1019703260_0001_r_000000_0
2023-04-11 01:12:35,489 INFO mapred.LocalJobRunner: reduce task executor complete.
2023-04-11 01:12:35,902 INFO mapreduce.Job: Job job_local1019703260_0001 running in uber mode : false
2023-04-11 01:12:35,903 INFO mapreduce.Job: map 100% reduce 100%
2023-04-11 01:12:35,904 INFO mapreduce.Job: Job job_local1019703260_0001 completed successfully
2023-04-11 01:12:35,912 INFO mapreduce.Job: Counters: 30
File System Counters
FILE: Number of bytes read=12574
FILE: Number of bytes written=1297124
FILE: Number of read operations=0
FILE: Number of large read operations=0
FILE: Number of write operations=0
Map-Reduce Framework
Map input records=6
Map output records=6
Map output bytes=2418
Map output materialized bytes=2448
Input split bytes=128
Combine input records=0
Combine output records=0
Reduce input groups=1
Reduce shuffle bytes=2448
Reduce input records=6
Reduce output records=6
Spilled Records=12
Shuffled Maps =1
Failed Shuffles=0
Merged Map outputs=1
GC time elapsed (ms)=22
Total committed heap usage (bytes)=394264576
Shuffle Errors
BAD_ID=0
CONNECTION=0
IO_ERROR=0
WRONG_LENGTH=0
WRONG_MAP=0
WRONG_REDUCE=0
File Input Format Counters
Bytes Read=396
File Output Format Counters
Bytes Written=2434
20120090@thehoang:~/BigDataLabs/Lab_1/Lab_2$
20120090@thehoang: ~/BigDataLabs/Lab_1/Lab_2/output
File Edit View Search Terminal Help
GNU nano 6.2 part-r-00000
11116,6de055355d3b3fc38b86507ab67a35e408e6c1bdb0b0ee8f6c06cfd1878f8db4,c8fb40aa89c32b47268092d2478a061ec91e34b21cbd8b072123e21c338bdae0,87a8e469e
11115,e8c330e955d0f7ef3bea25c50019ee357d10a8ffe27d20e1679c220f9158aa7f,f1749336339a5126f57e35a8f468bbb732f5b7eae1bff0fa2e754d94b3c56642,87a8e469e
11114,680a5c27445df32dd13016dcda0e7d8cb6e0cb022fa2fb1e7db6de3565d6d0d5,5b0569f7f358f54a6b66aca4c36d4edb5dbb58c9200811287448a3dc4895c42f,87a8e469e
11113,9c73aa1a2461934a8c0dc0da9fecc91de965e8c7f8667dfeafbdde73e4d2d604,c03b5b84e934f7ab129170bba1a1717eea4947308080ce92d6e55cc3e466fc50,87a8e469e
11112,7874b5a9c649d7a4675b1f208498f865783c9a20787264ab1c9ebdd2f2a83852,8fbbcbfbc9529b791ec25084916ea96f0d932f150311bc519e42d8ae9008034e,87a8e469e
11111,015c0eb43bc3715e8295a91fc029deaffe3ca383904e12b4f00021f8577c93c5,948773d2942375278cb8621a22c58755b0f774ba0c4d5b9e4ff39e8f7e624f3e,87a8e469e
[Read 6 lines]
^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute ^C Location M-U Undo M-A Set Mark M-] To Bracket
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify ^/ Go To Line M-E Redo M-6 Copy ^Q Where Was

8 Problem 8: Music Track Program

Input: UserId, TrackId, Shared, Radio, Skip

Output: TrackID, the number of unique users

Idea: I reference to the solution and github.

https://gist.github.com/deshpandetanmay/70277a43dc9332819c93

Map:

Split lines, if it is a valid record then write to context

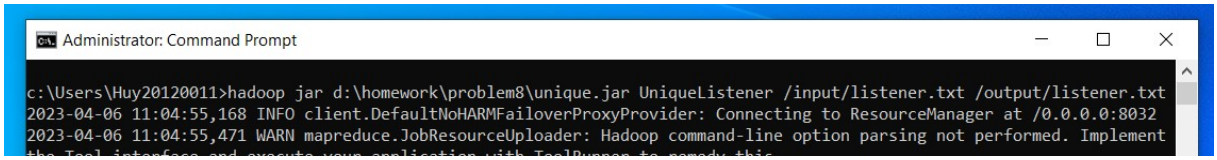
```
public static class UniqueListenerMapper extends
            Mapper<Object, Text, IntWritable, IntWritable> {

        IntWritable trackId = new IntWritable();
        IntWritable userId = new IntWritable();

        public void map(Object key, Text value,
                Mapper<Object, Text, IntWritable, IntWritable>.Context context)
                throws IOException, InterruptedException {

            String[] parts = value.toString().split("[|]");
            trackId.set(Integer.parseInt(parts[LastFMConstants.TRACK_ID]));
            userId.set(Integer.parseInt(parts[LastFMConstants.USER_ID]));

            if (parts.length == 5) {
                context.write(trackId, userId);
            } else {
                // add counter for invalid records
                context.getCounter(COUNTERS.INVALID_RECORD_COUNT).increment(1L);
            }

        }
    }
```

Reduce: Count the number of unique users

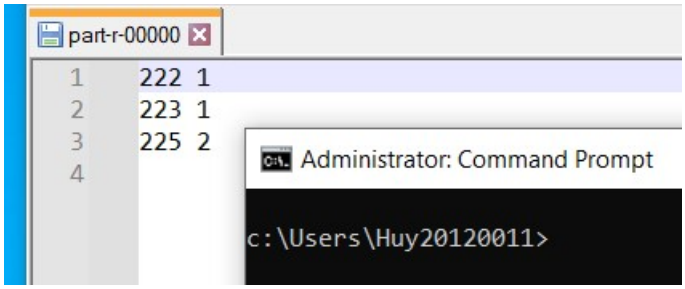
```
    public static class UniqueListenerReducer extends
            Reducer<IntWritable, IntWritable, IntWritable, IntWritable> {
```

```
        public void reduce(
                IntWritable trackId,
                Iterable<IntWritable> userIds,
                Reducer<IntWritable, IntWritable, IntWritable, IntWritable>.Context context)
                throws IOException, InterruptedException {

            Set<Integer> userIdSet = new HashSet<Integer>();
            for (IntWritable userId : userIds) {
                userIdSet.add(userId.get());
            }
            IntWritable size = new IntWritable(userIdSet.size());
            context.write(trackId, size);
        }
    }
```

Run:



Result:



9 Problem 9: Call Data Record

Input: list of data, each line includes caller phone number, recipient phone number, call start time, call end time, STD flag, each information separated by vertical bar (|) Consider following format FromPhoneNumber|ToPhoneNumber|CallStartTime|CallEndTime|STDFlag

Output: all phone numbers who are making more than 60 minutes of STD calls.

Idea: extract caller phone number, call start and end time from data. Calculate the total call time of each phone number, save all the phone numbers have total time more than 60 minutes.

Code: ***Mapper*** *map() function*:

- Use split() command to cut string, save information into an array
- For the phone number has STD call, use get_time() function to get time in milliseconds of call start time and call end time, call time in millisec is saved to dur, in minutes is saved to duration

```
Text phone_num = new Text();
LongWritable duration = new LongWritable();

String[] word = value.toString().split("[|]");

if (word[4].equalsIgnoreCase("1")) {
    phone_num.set(word[0]);
    String call_end = word[3];
    String call_start = word[2];
    long dur = get_time(call_end) - get_time(call_start);  //dur: time in millisecond
    duration.set(dur / (1000 * 60));    //duration: time in minute
    context.write(phone_num, duration);
}
```

get_time() function: - Use SimpleDateFormat library to convert string data to Date data then use getTime() command to get time (in millisec)

```
private long get_time(String str) {
    SimpleDateFormat formatter = new SimpleDateFormat("yyyy-MM-dd HH:mm:ss");
    Date date = null;
    try {
        date = formatter.parse(str);
    } catch (ParseException e) {
```

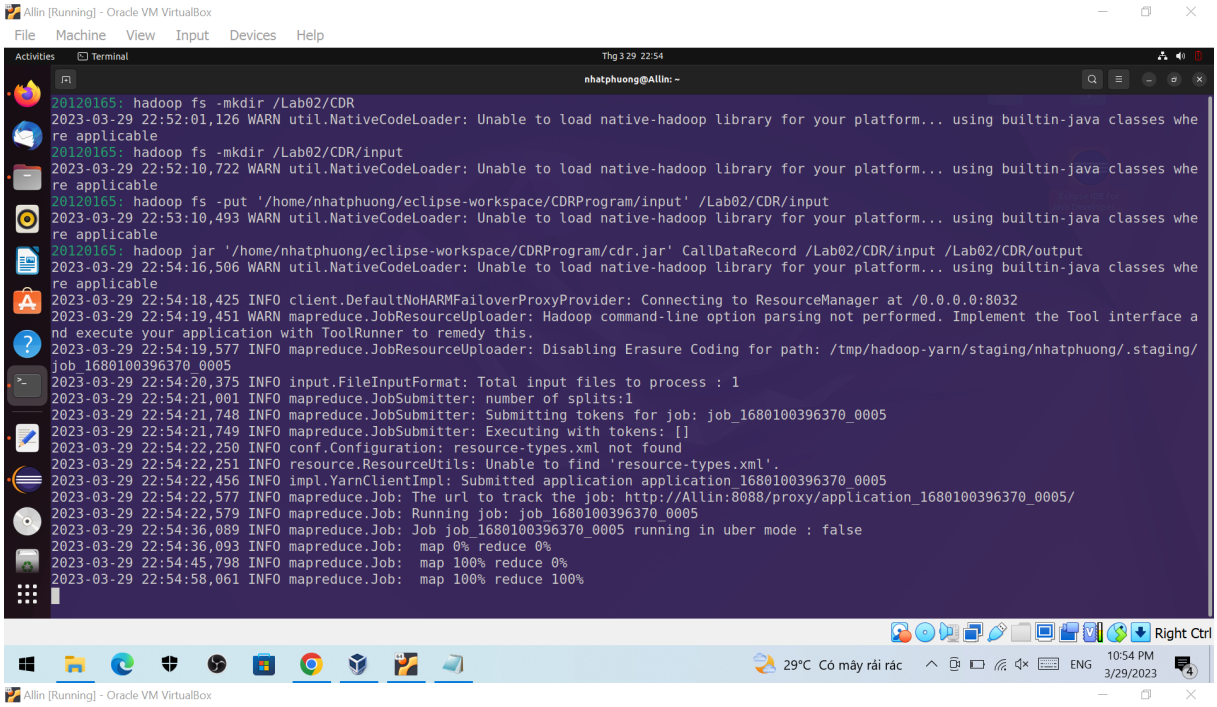
```
            e.printStackTrace();
        }
        return date.getTime();
    }
```

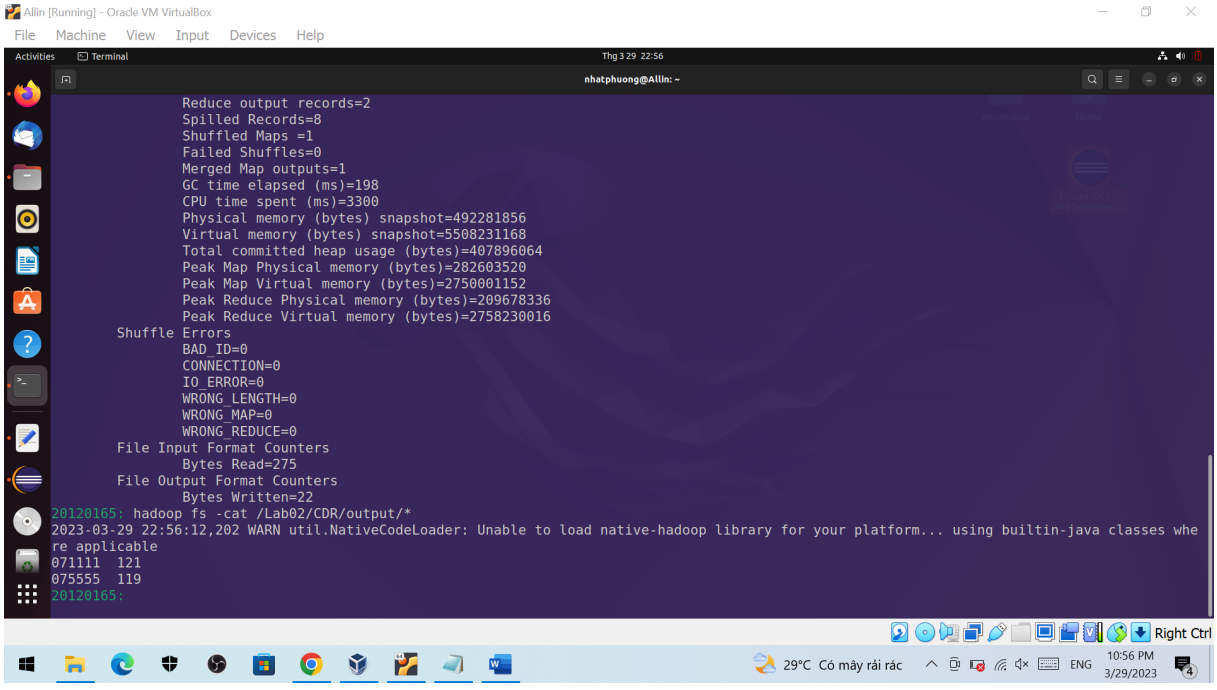
reducer() function: - Calculate the total call time of 1 phone number, if total time is more thanh 60 minutes, print the result.

```
LongWritable result = new LongWritable();
long sum = 0;
for (LongWritable val : values) {
    sum += val.get();
}
result.set(sum);
if (sum >= 60) {
    context.write(key, result);
}
```

Run program

```
071111|082982|2023-03-29 10:00:00|2023-03-29 12:01:00|1
033333|076234|2023-03-29 10:00:00|2023-03-29 10:28:00|1
094444|087659|2023-03-29 10:00:00|2023-03-29 13:00:00|0
075555|094444|2023-03-29 10:00:00|2023-03-29 10:30:00|1
075555|037290|2023-03-29 12:50:50|2023-03-29 13:00:00|1
039899|037290|2023-03-29 22:33:10|2023-03-29 22:40:00|1
036929|086273|2023-03-29 11:00:00|2023-03-29 12:29:00|0
072942|093723|2023-03-29 20:10:02|2023-03-29 20:30:00|0
092740|072942|2023-03-29 05:40:02|2023-03-29 05:45:00|0
```


Allin [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 3 29 22:54
nhatphuong@Allin: ~
20120165: hadoop fs -mkdir /Lab02/CDR
2023-03-29 22:52:01,126 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
20120165: hadoop fs -mkdir /Lab02/CDR/input
2023-03-29 22:52:10,722 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
20120165: hadoop fs -put '/home/nhatphuong/eclipse-workspace/CDRProgram/input' /Lab02/CDR/input
2023-03-29 22:53:10,493 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
20120165: hadoop jar '/home/nhatphuong/eclipse-workspace/CDRProgram/cdr.jar' CallDataRecord /Lab02/CDR/input /Lab02/CDR/output
2023-03-29 22:54:16,506 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
2023-03-29 22:54:18,425 INFO client.DefaultNoHARMFailoverProxyProvider: Connecting to ResourceManager at /0.0.0.0:8032
2023-03-29 22:54:19,451 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute your application with ToolRunner to remedy this.
2023-03-29 22:54:19,577 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/nhatphuong/.staging/job_1680100396370_0005
2023-03-29 22:54:20,375 INFO input.FileInputFormat: Total input files to process : 1
2023-03-29 22:54:21,001 INFO mapreduce.JobSubmitter: number of splits:1
2023-03-29 22:54:21,748 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1680100396370_0005
2023-03-29 22:54:21,749 INFO mapreduce.JobSubmitter: Executing with tokens: []
2023-03-29 22:54:22,250 INFO conf.Configuration: resource-types.xml not found
2023-03-29 22:54:22,251 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
2023-03-29 22:54:22,456 INFO impl.YarnClientImpl: Submitted application application_1680100396370_0005
2023-03-29 22:54:22,577 INFO mapreduce.Job: The url to track the job: http://Allin:8088/proxy/application_1680100396370_0005/
2023-03-29 22:54:22,579 INFO mapreduce.Job: Running job: job_1680100396370_0005
2023-03-29 22:54:36,089 INFO mapreduce.Job: Job job_1680100396370_0005 running in uber mode : false
2023-03-29 22:54:36,093 INFO mapreduce.Job: map 0% reduce 0%
2023-03-29 22:54:45,798 INFO mapreduce.Job: map 100% reduce 0%
2023-03-29 22:54:58,061 INFO mapreduce.Job: map 100% reduce 100%
Right Ctrl
29°C Có mây rải rác
ENG
10:54 PM
3/29/2023


Allin [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 3 29 22:56
nhatphuong@Allin: ~
Reduce output records=2
Spilled Records=8
Shuffled Maps =1
Failed Shuffles=0
Merged Map outputs=1
GC time elapsed (ms)=198
CPU time spent (ms)=3300
Physical memory (bytes) snapshot=492281856
Virtual memory (bytes) snapshot=5508231168
Total committed heap usage (bytes)=407896064
Peak Map Physical memory (bytes)=282603520
Peak Map Virtual memory (bytes)=2750001152
Peak Reduce Physical memory (bytes)=209678336
Peak Reduce Virtual memory (bytes)=2758230016
Shuffle Errors
BAD_ID=0
CONNECTION=0
IO_ERROR=0
WRONG_LENGTH=0
WRONG_MAP=0
WRONG_REDUCE=0
File Input Format Counters
Bytes Read=275
File Output Format Counters
Bytes Written=22
20120165: hadoop fs -cat /Lab02/CDR/output/*
2023-03-29 22:56:12,202 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
071111 121
075555 119
20120165:
Right Ctrl
29°C Có mây rải rác
ENG
10:56 PM
3/29/2023

10 Problem 10: Connected Components

We use the idea from [1].

[1] V. Rastogi, A. Machanavajjhala, L. Chitnis, and A. Das Sarma, "Finding Connected Components on Map-reduce in Logarithmic Rounds," Mar. 2012, [Online]. Available: http://arxiv.org/abs/1203.5387.