Implement a MapReduce application using Hadoop to obtain, programmatically (using Python or your preferred language), the following:

Q) What is number of open, assigned and closed issues for the following 3 complaint types:

Python Script: complaint_count.py

1. All noise complaints (See the column “Complaint Type”)
2. Street Condition
3. Illegal Parking

Final Script Output:

"Count of Noise_Complaints": 1771120
"Count of Illegal Parking Complaints": 561212
"Count of Street Condition Complaints": 434132

Sample Script Output: (1000 Records)

"Count of Street Condition Complaints": 16
"Count of Noise_Complaints": 766
"Count of Illegal Parking Complaints": 18

Q) For the year 2017, for each quarter (Jan-Mar, April-June, July-Sept, Oct-Dec)

1. **What is the average number of the above complaints per month?**

Python Script: average_count.py

Final Script Output:

"Average number of noise complaints per month in Q1 (Jan - Mar)": 27964
"Average number of street complaints per month in Q1 (Jan - Mar)": 8581
"Average number of illegal parking complaints per month in Q1 (Jan - Mar)": 10772
"Average number of noise complaints per month in Q2 (Apr - June)": 43789
"Average number of street complaints per month in Q2 (Apr - June)": 10704
"Average number of illegal parking complaints per month in Q2 (Apr - June)": 12971
"Average number of noise complaints per month in Q3 (July - Sept)": 43990
"Average number of street complaints per month in Q3 (July - Sept)": 6590
"Average number of illegal parking complaints per month in Q3 (July - Sept)": 12784
"Average number of noise complaints per month in Q4 (Oct - Dec)": 33286
"Average number of street complaints per month in Q4 (Oct - Dec)": 5212
"Average number of illegal parking complaints per month in Q4 (Oct - Dec)" : 12179

Sample Script Output (1000 Records):

"Average number of noise complaints per month in Q1 (Jan - Mar)": 255
"Average number of street complaints per month in Q1 (Jan - Mar)": 5
"Average number of illegal parking complaints per month in Q1 (Jan - Mar)": 6
"Average number of noise complaints per month in Q2 (Apr - June)": 0
"Average number of street complaints per month in Q2 (Apr - June)": 0

"Average number of illegal parking complaints per month in Q2 (Apr - June)": 0
"Average number of street complaints per month in Q3 (July - Sept)": 0
"Average number of noise complaints per month in Q3 (July - Sept)": 0
"Average number of illegal parking complaints per month in Q3 (July - Sept)": 0

"Average number of street complaints per month in Q4 (Oct - Dec)": 0
"Average number of noise complaints per month in Q4 (Oct - Dec)": 0
"Average number of illegal parking complaints per month in Q4 (Oct - Dec)": 0

2. Which borough had the highest number of" Illegal Parking" in each quarter?

Python Script: illegal_parking_count.py

Final Script Output:

"Highest number of illegal parking borough in Q1 (Jan-Mar)": ["BROOKLYN"]
"Highest number of illegal parking borough in Q2 (Apr-June)": ["BROOKLYN"]
"Highest number of illegal parking borough in Q3 (July-Sept)": ["BROOKLYN"]
"Highest number of illegal parking borough in Q4 (Oct-Dec)": ["BROOKLYN"]

Sample Script Output (1000 Records):

"Highest number of illegal parking borough in Q1 (Jan-Mar)": ["QUEENS"]
"Highest number of illegal parking borough in Q2 (Apr-June)": ["None"]
"Highest number of illegal parking borough in Q3 (July-Sept)": ["None"]
"Highest number of illegal parking borough in Q4 (Oct-Dec)": ["None"]

Q) Provide the code that you have developed to run the proposed problem in Hadoop/HDFS.

complaint_count.py

```
## This script attempts to find the number of open, assigned and closed issues for the following 3 complaint types:
## 1. All noise complaints
## 2. Street Condition
## 3. Illegal Parking

from mrjob.job import MRJob

class MR311ComplaintCount(MRJob):

    def mapper(self, _, line):
        attr_list = line.split(",")

        count_noise_complaints = 0                                  ## Initialize Variables
        count_street_complaints = 0
        count_parking_complaints = 0

        if (attr_list[0] == "Unique Key" or attr_list[1] == "Created Date"):   ## Ignore file header
            pass
        elif 'Noise' in attr_list[5]:                               ## Checking complaint type
            count_noise_complaints += 1
        elif 'Street Condition' in attr_list[5]:
            count_street_complaints += 1
        elif 'Illegal Parking' in attr_list[5]:
            count_parking_complaints += 1
        else:
            pass

        yield "Count of Noise_Complaints", count_noise_complaints
        yield "Count of Street Condition Complaints", count_street_complaints
        yield "Count of Illegal Parking Complaints", count_parking_complaints

    def reducer(self, key, values):
        yield key, sum(values)


if __name__ == '__main__':
```

```
MR311ComplaintCount.run()
```

average_count.py

```
## This script attempts to find the average number of different complaint types for each quarter for a given year

from mrjob.job import MRJob
from datetime import datetime

class MR311ServiceRequests(MRJob):

    def mapper(self, _, line):
        q1_noise = 0                    ## Initialize Variables
        q1_parking = 0
        q1_street = 0
        q2_noise = 0
        q2_parking = 0
        q2_street = 0
        q3_noise = 0
        q3_parking = 0
        q3_street = 0
        q4_noise = 0
        q4_parking = 0
        q4_street = 0


        attr_list = line.split(",")                             ## Splitting each line of the file

        formatted_time = datetime

        if attr_list[1] !=  "Created Date":                     ## Formatting created date attribute
            attr_list[1] = attr_list[1][:-2].strip()
            formatted_time = datetime.strptime(attr_list[1], "%m/%d/%Y %H:%M:%S")
        else:
            pass

        if (formatted_time.year == 2017):                                       ## Checking year
            if (formatted_time.month == 1) or (formatted_time.month == 2) or (formatted_time.month == 3):
                if 'Noise' in attr_list[5]:
                    q1_noise += 1
                elif 'Illegal Parking' in attr_list[5]:
                    q1_parking += 1

                elif 'Street Condition' in attr_list[5]:
                    q1_street += 1

            elif (formatted_time.month == 4) or (formatted_time.month == 5) or (formatted_time.month == 6):
                if 'Noise' in attr_list[5]:
                    q2_noise += 1
                elif 'Illegal Parking' in attr_list[5]:
                    q2_parking += 1

                elif 'Street Condition' in attr_list[5]:
                    q2_street += 1

            elif (formatted_time.month == 7) or (formatted_time.month == 8) or (formatted_time.month == 9):
                if 'Noise' in attr_list[5]:
                    q3_noise += 1
                elif 'Illegal Parking' in attr_list[5]:
                    q3_parking += 1

                elif 'Street Condition' in attr_list[5]:
                    q3_street += 1

            elif (formatted_time.month == 10) or (formatted_time.month == 11) or (formatted_time.month == 12):
                if 'Noise' in attr_list[5]:
                    q4_noise += 1
                elif 'Illegal Parking' in attr_list[5]:
```

```
                q4_parking += 1
            elif 'Street Condition' in attr_list[5]:
                q4_street += 1

        else:
            pass

    else:
        pass

    yield "Average number of noise complaints per month in Q1 (Jan - Mar)", q1_noise
    yield "Average number of illegal parking complaints per month in Q1 (Jan - Mar)", q1_parking
    yield "Average number of street complaints per month in Q1 (Jan - Mar)", q1_street

    yield "Average number of noise complaints per month in Q2 (Apr - June)", q2_noise
    yield "Average number of illegal parking complaints per month in Q2 (Apr - June)", q2_parking
    yield "Average number of street complaints per month in Q2 (Apr - June)", q2_street

    yield "Average number of noise complaints per month in Q3 (July - Sept)", q3_noise
    yield "Average number of illegal parking complaints per month in Q3 (July - Sept)", q3_parking
    yield "Average number of street complaints per month in Q3 (July - Sept)", q3_street

    yield "Average number of noise complaints per month in Q4 (Oct - Dec)", q4_noise
    yield "Average number of illegal parking complaints per month in Q4 (Oct - Dec)", q4_parking
    yield "Average number of street complaints per month in Q4 (Oct - Dec)", q4_street


  def reducer(self, key, values):
    yield key, round(sum(values)/3)          ## Finding average per month


if __name__ == '__main__':
  MR311ServiceRequests.run()
```

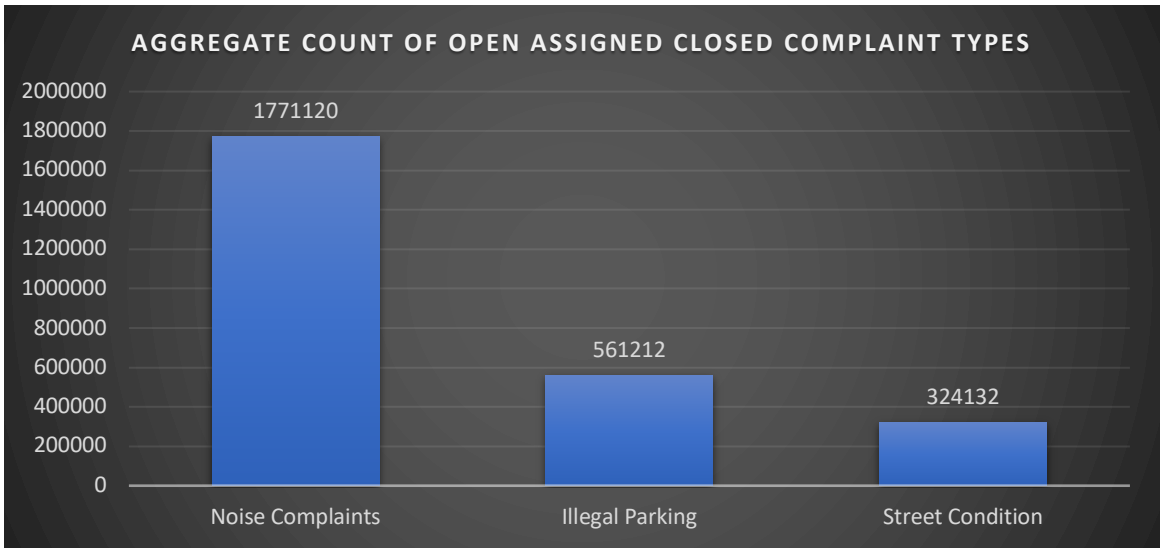
illegal_parking_count.py

This script attempts to find the number borough with the highest number of illegal parking each quarter for a given year

```
from mrjob.job import MRJob
from datetime import datetime

class MR311ServiceRequests(MRJob):

  def mapper(self, _, line):
    q1_parking_borough = []          ## Initializing empty lists for holding parking borough names
    q2_parking_borough = []
    q3_parking_borough = []
    q4_parking_borough = []

    attr_list = line.split(",")      ## Splitting each line of the input file

    formatted_time = datetime

    if attr_list[1] !=  "Created Date":                  ## Formatting created date attribute
      attr_list[1] = attr_list[1][:-2].strip()
      formatted_time = datetime.strptime(attr_list[1], "%m/%d/%Y %H:%M:%S")
    else:
      pass

    if (formatted_time.year == 2017):                    ## Checking year
      if (formatted_time.month == 1) or (formatted_time.month == 2) or (formatted_time.month == 3):
        if 'Illegal Parking' in attr_list[5]:          ## Checking Parking Borough
          q1_parking_borough.append(attr_list[30])

      elif (formatted_time.month == 4) or (formatted_time.month == 5) or (formatted_time.month == 6):
        if 'Illegal Parking' in attr_list[5]:
          q2_parking_borough.append(attr_list[30])
```

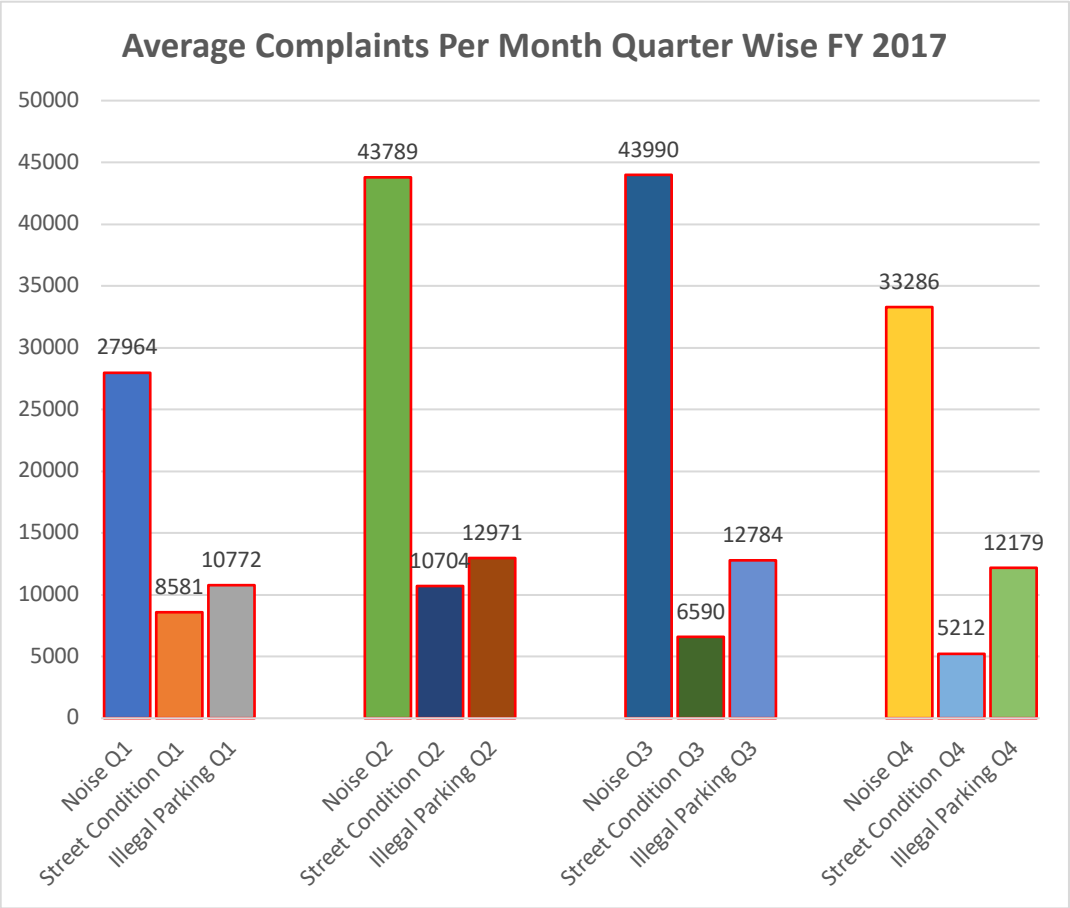
```
            elif (formatted_time.month == 7) or (formatted_time.month == 8) or (formatted_time.month == 9):
                if 'Illegal Parking' in attr_list[5]:
                    q3_parking_borough.append(attr_list[30])

            elif (formatted_time.month == 10) or (formatted_time.month == 11) or (formatted_time.month == 12):
                if 'Illegal Parking' in attr_list[5]:
                    q4_parking_borough.append(attr_list[30])
            else:
                pass

        else:
            pass

        yield("Highest number of illegal parking borough in Q1 (Jan-Mar)",q1_parking_borough)
        yield("Highest number of illegal parking borough in Q2 (Apr-June)",q2_parking_borough)
        yield("Highest number of illegal parking borough in Q3 (July-Sept)",q3_parking_borough)
        yield("Highest number of illegal parking borough in Q4 (Oct-Dec)",q4_parking_borough)

    def reducer(self, key, values):
        try:
            values = [x for x in values if x]                    ## Checking for empty values the list and removing them
            yield key, max(values, key=values.count)             ## Picking most frequent value in the list
        except ValueError:                                       ## Compatible code for Python 2.7
            values = ["None"]
            yield key, values

            #yield key, max(values, key=values.count, default = "None")

if __name__ == '__main__':
    MR311ServiceRequests.run()
```

Q) Provide the results obtained (statistics e.g., using plots)



Note: Noise Complaints includes aggregate count of the following Sub types:

“Noise | Noise - Street/Sidewalk | Noise – Vehicle | Noise – Residential | Noise – Commercial | Noise – Helicopter “



Note:

Q1 – Quarter 1 (Jan – Mar), Q2 – Quarter 2 (Apr – June), Q3 – Quarter 3 (July – Sep), Q4 – Quarter 4 (Oct – Dec)

Quarter Details (Year 2017)	Highest Illegal Parking Borough Name
Q1 (Jan – Mar)	Brooklyn
Q2 (Apr – June)	Brooklyn
Q3 (July – Sep)	Brooklyn
Q4 (Oct – Dec)	Brooklyn

Q) Specific question: describe the order in which map and reduce tasks are executed in Hadoop and the duration of map and reduce phases for the different job execution steps.

Script Name: complaint_count.py	Script Name: average_count.py	Script Name: illegal_parking_count.py
Execution Step: python complaint_count.py s3://pgarias-bucket-cloud.s3.us-east-2.amazonaws.com/311_Service_Requests_from_2015_to_Present.csv -r emr –output-dir=s3://ranjeeta-hw2-us-east-2/final_1 **Log File:** aws s3 ls s3://ranjeeta-hw2-us-east-2/final_1	**Execution Step:** python average_count.py s3://pgarias-bucket-cloud.s3.us-east-2.amazonaws.com/311_Service_Requests_from_2015_to_Present.csv -r emr –output-dir=s3://ranjeeta-hw2-us-east-2/final_2 **Log File:** aws s3 ls s3://ranjeeta-hw2-us-east-2/final_2	**Execution Step:** python illegal_parking_count.py s3://pgarias-bucket-cloud.s3.us-east-2.amazonaws.com/311_Service_Requests_from_2015_to_Present.csv -r emr –output-dir=s3://ranjeeta-hw2-us-east-2/final_3 **Log File:** aws s3 ls s3://ranjeeta-hw2-us-east-2/final_3
Order of Map Reduce tasks: For every complaint type, count of number of records is calculated in the mapper. Reducer is simply used to print out the count.	**Order of Map Reduce tasks:** For every complaint type, in the mapper corresponding year, month is checked, and count of records is calculated. Reducer is used to sum the counts and display the average per quarter.	**Order of Map Reduce tasks:** For illegal parking complaint type, in the mapper corresponding year, month is checked, and parking borough is determined. Reducer is used to determine and display the name of the most frequently occurring borough.
Duration: Data-local map tasks=89 Killed map tasks=3 Killed reduce tasks=1 Launched map tasks=89 Launched reduce tasks=10 Total megabyte-milliseconds taken by all map tasks=5882479104 Total megabyte-milliseconds taken by all reduce tasks=4156360704 Total time spent by all map tasks (ms)=3829739 Total time spent by all maps in occupied slots (ms)=183827472 Total time spent by all reduce tasks (ms)=1352982 Total time spent by all reduces in occupied slots (ms)=129886272 Total vcore-milliseconds taken by all map tasks=3829739 Total vcore-milliseconds taken by all reduce tasks=1352982 CPU time spent (ms)=1231710 Combine input records=0 Combine output records=0 Failed Shuffles=0 GC time elapsed (ms)=78471 Input split bytes=10947 Map input records=10420595 Map output bytes=1156686045 Map output materialized bytes=63417476 Map output records=31261785	**Duration:** Data-local map tasks=89 Failed map tasks=1 Killed map tasks=1 Killed reduce tasks=2 Launched map tasks=90 Launched reduce tasks=10 Other local map tasks=1 Total megabyte-milliseconds taken by all map tasks=12784375296 Total megabyte-milliseconds taken by all reduce tasks=10375268352 Total time spent by all map tasks (ms)=8323161 Total time spent by all maps in occupied slots (ms)=399511728 Total time spent by all reduce tasks (ms)=3377366 Total time spent by all reduces in occupied slots (ms)=324227136 Total vcore-milliseconds taken by all map tasks=8323161 Total vcore-milliseconds taken by all reduce tasks=3377366 CPU time spent (ms)=4704540 Combine input records=0 Combine output records=0 Failed Shuffles=0 GC time elapsed (ms)=81530 Input split bytes=10947 Map input records=10420595 Map output bytes=8930449915	**Duration:** Data-local map tasks=89 Killed map tasks=1 Launched map tasks=89 Launched reduce tasks=9 Total megabyte-milliseconds taken by all map tasks=7794066432 Total megabyte-milliseconds taken by all reduce tasks=5608461312 Total time spent by all map tasks (ms)=5074262 Total time spent by all maps in occupied slots (ms)=243564576 Total time spent by all reduce tasks (ms)=1825671 Total time spent by all reduces in occupied slots (ms)=175264416 Total vcore-milliseconds taken by all map tasks=5074262 Total vcore-milliseconds taken by all reduce tasks=1825671 CPU time spent (ms)=2262570 Combine input records=0 Combine output records=0 Failed Shuffles=0 GC time elapsed (ms)=85484 Input split bytes=10947 Map input records=10420595 Map output bytes=2658633888 Map output materialized bytes=135263048 Map output records=41682380 Merged Map outputs=801

Merged Map outputs=801 **Physical memory (bytes) snapshot=61739741184** **Reduce input groups=3** **Reduce input records=31261785** **Reduce output records=3** **Reduce shuffle bytes=63417476** **Shuffled Maps =801** **Spilled Records=62523570** **Total committed heap usage (bytes)=55600218112** **Virtual memory (bytes) snapshot=336187707392**	**Map output materialized bytes=454214416** **Map output records=125047140** **Merged Map outputs=801** **Physical memory (bytes) snapshot=66615840768** **Reduce input groups=12** **Reduce input records=125047140** **Reduce output records=12** **Reduce shuffle bytes=454214416** **Shuffled Maps =801** **Spilled Records=250094280** **Total committed heap usage (bytes)=60947431424** **Virtual memory (bytes) snapshot=336211337216**	**Physical memory (bytes) snapshot=65759744000** **Reduce input groups=4** **Reduce input records=41682380** **Reduce output records=4** **Reduce shuffle bytes=135263048** **Shuffled Maps =801** **Spilled Records=83364760** **Total committed heap usage (bytes)=59907244032** **Virtual memory (bytes) snapshot=336150122496**

Appendix

Sample File (Extract)	Final File
https://pgarias-bucket-cloud.s3.us-east-2.amazonaws.com/311_Service_Requests_from_2015_to_Present_head_1000.csv	https://pgarias-bucket-cloud.s3.us-east-2.amazonaws.com/311_Service_Requests_from_2015_to_Present.csv

AWS S3 Output Directory: s3://ranjeeta-hw2-us-east-2

.mrjob.conf

```
emr:
  aws_access_key_id: AKIAY7FBTDUDJIOVCK6B
  aws_secret_access_key: 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

  region: us-east-2
  subnet: subnet-7c685114
  ec2_key_pair: hw2_ids
  ec2_key_pair_file: /Users/ranjeeta/.ssh/hw2_ids.pem
  ssh_tunnel: true

  instance_type: m4.large
  master_instance_type: m4.large
  num_core_instances: 5
  interpreter: python2.7
  bootstrap:
  - sudo yum install -y gcc-c++
  - sudo pip-2.7 install mrjob
```