Data Mining the US DOT Statistics on Aviation

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Introduction

The goal of this paper is to analyze the transportation dataset from the US Bureau of Transportation Statistics (BTS) that is hosted as an Amazon EBS volume snapshot and answer a set of interesting questions about it.The dataset contains data and statistics on Aviation up to 2008 in CSV format. It contains flight data such as departure and arrival delays, flight times, etc.

All code and full results can be found at https://github.com/stephendimig/cc-capstone .

Methods and Data

System Installation and Setup

All work for this paper was performed on Amazon Web Services using a virtual machine instance running HortonWorks Sandbox 2.1. An EBS volume was created from a pre-existing snapshot containing the BTS transportation data statistics and attached to the virtual machine. In addition to this basic setup, the Apache Cassandra NoSQL database and the R Programming Language were also installed.

Attribute	**Value**	**Description**
Inst. Type	C3.xlarge	
AMI ID	ami-36d95d5e	hortonworks 2.1 - sandbox
vCPUs	4	
Memory	7.5 GB	
Inst. Storage	128 GB	Increased the storage size
EBS Vol. ID	snap-23a9cf5e	BTS transportation data
R	3.2	R programming language
Cassandra	2-1.2.10-1	NoSQL Database

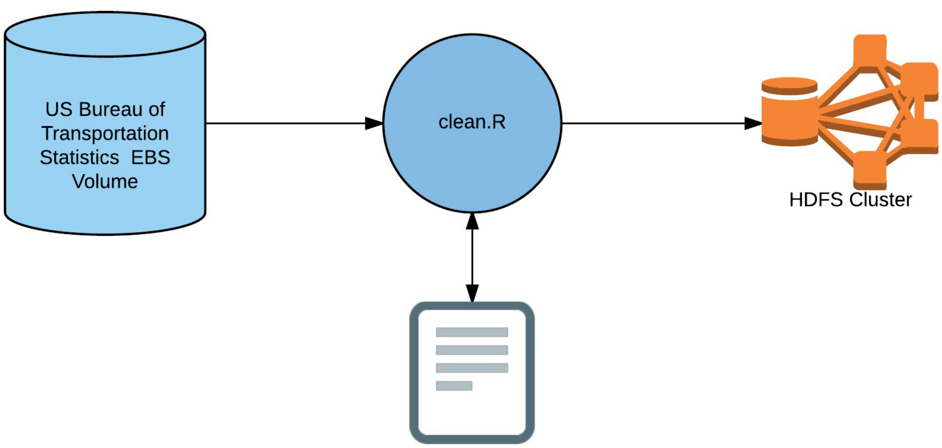
MapReduce is fantastic at parallellizing work done on large data sets, but due to it's nature it can be difficult to use for some smaller tasks. Rather than struggling to make MapReduce perform every task required here, several languages were used together to perform that task.

Language	Description
Java	Used for map reduce programs to solve problems in Group 1
Pig	A language that generates map reduce from an SQL-like syntax
R	Used for post processing data filtered by MapReduce
Python	Used to filter and process data
cql	SQL-like query language for Cassandra

R is a programming language and software environment for statistical computing. It is exceptional at dealing with tabular data like what was found in this set of problems, but does not scale and is performs poorly on large datasets. R was used to process data where the majority of the heavy lifting was already done using MapReduce (either with Java or Pig).

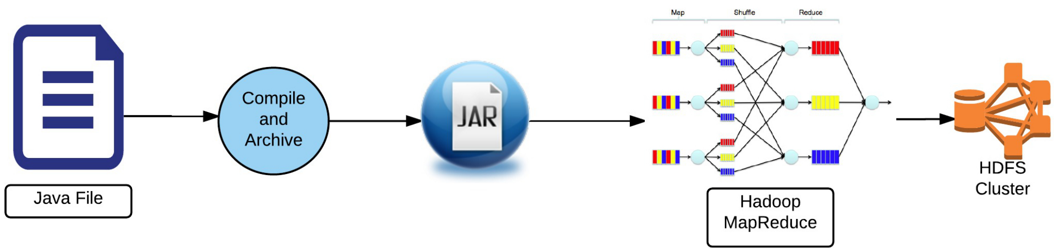
Cleaning the Data

The data was cleaned by reading it off the attached EBS data volume, processing it with R to filter out only the required fields, generating a temporary file, and then moving the file to HDFS.



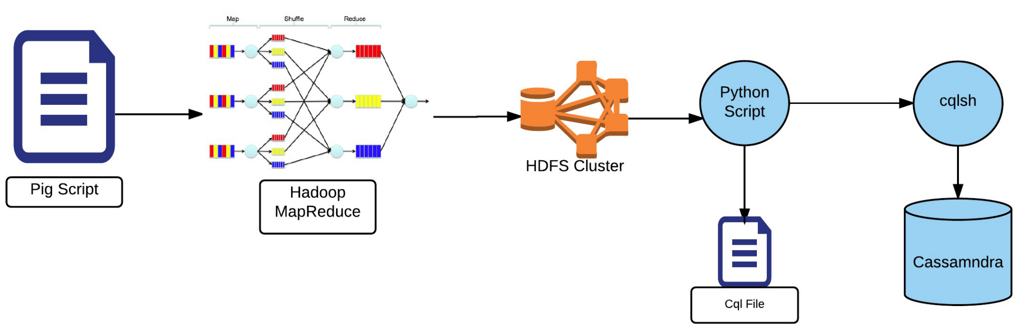
Group 1 Problems

The Group 1 Problems were solved using straight MapReduce with Java. For smaller problems this works well. A Java program is written using the Hadoop MapReduce framework and compiler. The jar file is then executed within Hadoop and the output is stored in HDFS.



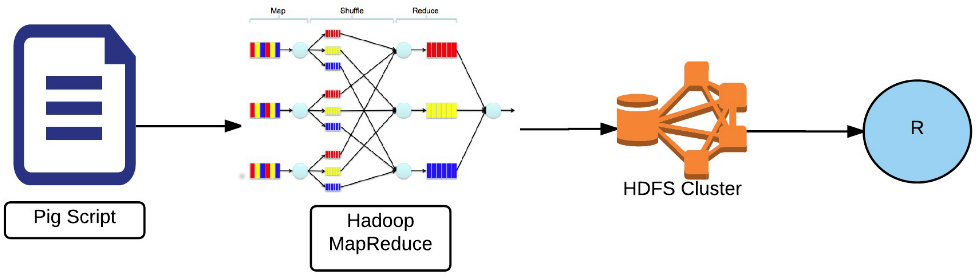
Group 2 Problems

The Group 2 Problems were the most complex as far as integration goes. I could not get the Cassandra/Pig interface to work so instead, I wrote a python language filter for each problem that took the output from the Pig script and created all of the cql commands that were required to load that data into Cassandra. The cql file was then run through cqlsh.



Group 3 Problems

The Group 3 problems required more analysis with no database interaction. This set of problems was solved with R directly reading the output of the Pig script from HDFS.



Results

Group 1 Questions

1.1 - Rank the top 10 most popular airports by numbers of flights to/from the airport.

Here are the top 3 airports by total flights. See Appendix A.1.1 for the full top 10.

Airport	Description	Flights
ORD	Chicago O'Hare International	12449354
ATL	Hartsfield Jackson Atlanta International	11540422
DFW	Dallas Fort Worth International	10799303

1.2 - Rank the top 10 airlines by on-time arrival performance.

Here are the top 3 carriers by average arrival delay. See A.1.2 for the full top 10 list.

Carrier	Description	Avg Delay
HA	Hawaiian Airlines, Inc.	3.9542668
AQ	9 Air Co Ltd	4.9505897
PS	Ukraine International Airlines	5.627902

1.3 - Rank the days of the week by on-time arrival performance.

Here are the top 3 days of the week by average arrival delay. See A.1.3 for the full top 10 list.

Day	Avg Delay
FRI	9.265108
MON	10.237862

SUN 10.864509

Group 2 Questions

Note that Cassandra does not output the queries in the same order that the INSERT operation was done. I included both the HDFS and Cassandra output for the queries to show they were in sorted order.

2.1 - For each airport X, rank the top-10 carriers in decreasing order of on-time departure performance from X. See Task 1 Queries for specific queries.

```
 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    CMI |             US |        2.8827
    CMI |             TW |        4.1582
    CMI |             PI |        4.5229
```

Top 3 carriers for the CMI airport. See Appendix A.2.1 for all queries.

2.2 - For each airport X, rank the top-10 airports in decreasing order of on-time departure performance from X. See Task 1 Queries for specific queries.

```
 origin | dest | dep_delay_avg
--------+------+---------------
    CMI |  ABI |             0
    CMI |  PIT |        2.1701
    CMI |  DAY |        3.6273
```

Top 3 destinations from CMI. See Appendix A.2.2 for all queries.

2.3 - For each source-destination pair X-Y, rank the top-10 carriers in decreasing order of on-time arrival performance at Y from X. See Task 1 Queries for specific queries.

```
 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    ATL |  PHX |             FL |             12.61
    ATL |  PHX |             US |            12.687
    ATL |  PHX |             HP |            13.367
```

Top 3 carriers from ATL to Phoenix. See Appendix A.2.3 for all queries.

Group 3 Questions

3.1 - Does the popularity distribution of airports follow a Zipf distribution? If not, what distribution does it follow?

Zipf distributions are used in linguistics. Zipf's law states that given some corpus of natural language utterances, the frequency of any word is inversely proportional to its rank in the frequency table. As applied to airports in our problem, this means that the highest ranked airport should have roughly double the nunmber of flights as the second rated. The second rated should have double the third and so on. Our data when the number of flights looks very much like a zipf distribution. There is enough doubt about that bulge in the middle though (a typical zipf has an almost 90 degree elbow) to warrant some analysis.

Analysis with the zipfR package shows our data is not a zipf distribution. So what distribution does our data follow? In our case, the data seem to fit a Weibull distribution almost perfectly.

See Appendix A.3.1 for a full analysis.

3.2 - Tom's Unusual Flight

```
[1] "JAX -> DFW Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
1545      845    JAX  DFW      AA 2008-09-09      722     1
[1] ""
[1] "DFW -> CRP Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
1493     3627    DFW  CRP      MQ 2008-09-11     1648     0
1521     3701    DFW  CRP      MQ 2008-09-11     1310     8
1438     3419    DFW  CRP      MQ 2008-09-11     1504     9
```

Tom's flight options from JAX->DFW->CRP on 9/09/2008. See Appendix A.3.2 for all queries.

Discussion

I like the results in the data but I believe it could have been cleaned better. Flight cancellations should be removed rater than replacing the delay values with zeroes which can skew the data for carriers with a smaller number of flights. I struggled on this project due to some technical difficulties with the ami image I was using. I figured that out though and had a lot of fun. I was wanting to do something similar to this in the Data Science specialization from Johns Hopkins since R is so slow with larger data sets. This proves to me you can extract the majority of the data using Hadoop and do the final analysis in R in a powerful way.

Appendix

A.1.1 Rank the top 10 most popular airports by numbers of flights to/from the airport.

Airport	Description	Flights
ORD	Chicago O'Hare International	12449354
ATL	Hartsfield Jackson Atlanta International	11540422
DFW	Dallas Fort Worth International	10799303
LAX	Los Angeles International	7723596
PHX	Phoenix Sky Harbor International Airport	6585534
DEN	Denver International	6273787
DTW	Detroit Metropolitan Wayne County	5636622
IAH	George Bush Intercontinental Houston	5480734
MSP	Minneapolis-St Paul International	5199213
SFO	San Francisco International	5171023

A.1.2 Rank the top 10 airlines by on-time arrival performance.

Carrier	Description	Avg Delay
HA	Hawaiian Airlines, Inc.	3.9542668
AQ	9 Air Co Ltd	4.9505897
PS	Ukraine International Airlines	5.627902
ML	Air Mediterranee	8.518365
WN	Southwest Airlines Co.	9.025299
F9	Frontier Airlines, Inc.	9.871182
PA	M/S Airblue (PVT) Ltd	10.189628
US	Piedmont Airlines, Inc	10.285916
NW	Northwest Airlines, Inc.	10.332496
EA	Operador Aereo Andalus S.A	10.360811

A.1.3 Rank the days of the week by on-time arrival performance.

Day	Avg Delay
FRI	9.265108
MON	10.237862
SUN	10.864509
SAT	11.019846
TUE	11.180128
WED	12.689463

THU 13.256688

A.2.1 For each airport X, rank the top-10 carriers in decreasing order of on-time departure performance from X. See Task 1 Queries for specific queries.

```
HDFS:

CMI US  2.8827454718779792
CMI TW  4.158153846153846
CMI PI  4.522930315664086
CMI OH  5.364254792826221
CMI DH  9.649402390438247
CMI EV  9.692660550458715
CMI MQ  11.754489920586439

BWI F9  4.916083916083916
BWI PA (1)  5.942857142857143
BWI CO  7.1413334153013865
BWI AA  7.657054909239057
BWI YV  7.675990675990676
BWI NW  8.30940419738016
BWI US  8.514172363028138
BWI DL  8.81506807645978
BWI TW  9.084856211928034
BWI EA  9.171986970684038

MIA 9E  0.5
MIA PA (1)  4.84346374454242
MIA EV  5.669603524229075
MIA XE  6.1033769813921435
MIA TZ  6.823035392921415
MIA NW  6.9902354593253
MIA US  7.427278231684071
MIA ML (1)  7.6319514661274015
MIA UA  8.273468482892824
MIA PI  9.063902838987394

LAX PS  4.973895803502589
LAX MQ  5.069745783395635
LAX OO  6.09525787073169
LAX ML (1)  7.101275318829708
LAX NW  7.252479152149109
LAX TZ  7.456864216054013
LAX US  7.803737590192616
LAX FL  8.082327701796729
LAX F9  8.362138132928548
LAX AA  8.41992740869826
```

```
IAH PI  4.643304503429764
IAH PA (1)  5.73430303030303
IAH NW  6.1597593951768665
IAH WN  6.232248922121386
IAH US  7.055723274437524
IAH AA  7.269662304240027
IAH TW  7.453365263423242
IAH OO  7.943149703051403
IAH HP  8.040625479074047
IAH DL  8.277057959223324

CASSANDRA:

 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    CMI |             DH |        9.6494
    CMI |             EV |        9.6927
    CMI |             MQ |        11.754
    CMI |             OH |        5.3643
    CMI |             PI |        4.5229
    CMI |             TW |        4.1582
    CMI |             US |        2.8827


 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    BWI |             AA |        7.6571
    BWI |             CO |        7.1413
    BWI |             DL |        8.8151
    BWI |             EA |         9.172
    BWI |             F9 |        4.9161
    BWI |             NW |        8.3094
    BWI |         PA (1) |        5.9429
    BWI |             TW |        9.0849
    BWI |             US |        8.5142
    BWI |             YV |         7.676


 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    MIA |             9E |           0.5
    MIA |             EV |        5.6696
    MIA |         ML (1) |         7.632
    MIA |             NW |        6.9902
    MIA |         PA (1) |        4.8435
    MIA |             PI |        9.0639
    MIA |             TZ |         6.823
    MIA |             UA |        8.2735
```

```
    MIA |              US |        7.4273
    MIA |              XE |        6.1034


 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    LAX |              AA |        8.4199
    LAX |              F9 |        8.3621
    LAX |              FL |        8.0823
    LAX |          ML (1) |        7.1013
    LAX |              MQ |        5.0697
    LAX |              NW |        7.2525
    LAX |              OO |        6.0953
    LAX |              PS |        4.9739
    LAX |              TZ |        7.4569
    LAX |              US |        7.8037


 origin | unique_carrier | dep_delay_avg
--------+----------------+---------------
    IAH |              AA |        7.2697
    IAH |              DL |        8.2771
    IAH |              HP |        8.0406
    IAH |              NW |        6.1598
    IAH |              OO |        7.9431
    IAH |          PA (1) |        5.7343
    IAH |              PI |        4.6433
    IAH |              TW |        7.4534
    IAH |              US |        7.0557
    IAH |              WN |        6.2322
```

A.2.2 For each airport X, rank the top-10 airports in decreasing order of on-time departure performance from X. See Task 1 Queries for specific queries.

```
HDFS:

CMI ABI 0.0
CMI PIT 2.170138888888889
CMI DAY 3.627294117647059
CMI STL 4.018326693227092
CMI PIA 4.632432432432433
CMI CVG 6.37942425672487
CMI DFW 9.556245151280063
CMI ATL 9.692660550458715
CMI ORD 11.943169761273209

BWI SAV 0.0
```

```
BWI MLB 2.384180790960452
BWI IAD 3.087108013937282
BWI DAB 3.8378378378378377
BWI SRQ 4.2688853671421025
BWI CHO 4.826086956521739
BWI MDT 4.901430842607313
BWI UCA 4.939938791124713
BWI OAJ 5.32
BWI GSP 5.431125131440589

MIA SHV 0.0
MIA BUF 1.0
MIA SAN 2.5136612021857925
MIA HOU 3.641137855579869
MIA SLC 4.070247933884297
MIA ISP 4.456647398843931
MIA PSE 4.946859903381642
MIA MCI 5.360544217687075
MIA TLH 5.442896639727776
MIA GNV 6.008032128514056

LAX RSW 0.0
LAX PIH 0.0
LAX LAX 0.0
LAX IDA 0.0
LAX DRO 0.0
LAX MAF 0.0
LAX SDF 0.0
LAX BZN 1.0
LAX VIS 2.4805194805194803
LAX PMD 3.0

IAH MSN 0.0
IAH MLI 0.0
IAH HOU 2.3019052956010086
IAH AGS 2.8315334773218144
IAH EFD 3.9198736358414705
IAH PIH 4.0
IAH VCT 5.3175675675675675
IAH RNO 5.507233065442021
IAH MTJ 5.635007849293563
IAH MDW 5.9158371040723985

SFO FAR 0.0
SFO PIH 0.0
SFO SDF 0.0
SFO MSO 0.5833333333333334
SFO LGA 1.2121212121212122
SFO OAK 2.548567870485679
```

```
SFO PIE 2.7283236994219653
SFO BNA 3.064916119620715
SFO SCK 4.0
SFO MEM 5.439648554124371

CASSANDRA:

 origin | dest | dep_delay_avg
--------+------+---------------
    CMI |  ABI |             0
    CMI |  ATL |        9.6927
    CMI |  CVG |        6.3794
    CMI |  DAY |        3.6273
    CMI |  DFW |        9.5562
    CMI |  ORD |        11.943
    CMI |  PIA |        4.6324
    CMI |  PIT |        2.1701
    CMI |  STL |        4.0183


 origin | dest | dep_delay_avg
--------+------+---------------
    BWI |  CHO |        4.8261
    BWI |  DAB |        3.8378
    BWI |  GSP |        5.4311
    BWI |  IAD |        3.0871
    BWI |  MDT |        4.9014
    BWI |  MLB |        2.3842
    BWI |  OAJ |          5.32
    BWI |  SAV |             0
    BWI |  SRQ |        4.2689
    BWI |  UCA |        4.9399


 origin | dest | dep_delay_avg
--------+------+---------------
    MIA |  BUF |             1
    MIA |  GNV |         6.008
    MIA |  HOU |        3.6411
    MIA |  ISP |        4.4566
    MIA |  MCI |        5.3605
    MIA |  PSE |        4.9469
    MIA |  SAN |        2.5137
    MIA |  SHV |             0
    MIA |  SLC |        4.0702
    MIA |  TLH |        5.4429


 origin | dest | dep_delay_avg
```

```
--------+------+---------------
    LAX |  BZN |              1
    LAX |  DRO |              0
    LAX |  IDA |              0
    LAX |  LAX |              0
    LAX |  MAF |              0
    LAX |  PIH |              0
    LAX |  PMD |              3
    LAX |  RSW |              0
    LAX |  SDF |              0
    LAX |  VIS |         2.4805


 origin | dest | dep_delay_avg
--------+------+---------------
    IAH |  AGS |         2.8315
    IAH |  EFD |         3.9199
    IAH |  HOU |         2.3019
    IAH |  MDW |         5.9158
    IAH |  MLI |              0
    IAH |  MSN |              0
    IAH |  MTJ |          5.635
    IAH |  PIH |              4
    IAH |  RNO |         5.5072
    IAH |  VCT |         5.3176


 origin | dest | dep_delay_avg
--------+------+---------------
    SFO |  BNA |         3.0649
    SFO |  FAR |              0
    SFO |  LGA |         1.2121
    SFO |  MEM |         5.4396
    SFO |  MSO |        0.58333
    SFO |  OAK |         2.5486
    SFO |  PIE |         2.7283
    SFO |  PIH |              0
    SFO |  SCK |              4
    SFO |  SDF |              0
```

A.2.3 For each source-destination pair X-Y, rank the top-10 carriers in decreasing order of on-time arrival performance at Y from X. See Task 1 Queries for specific queries.

```
HDFS:

CMI    ORD  MQ  15.739150630391507
```

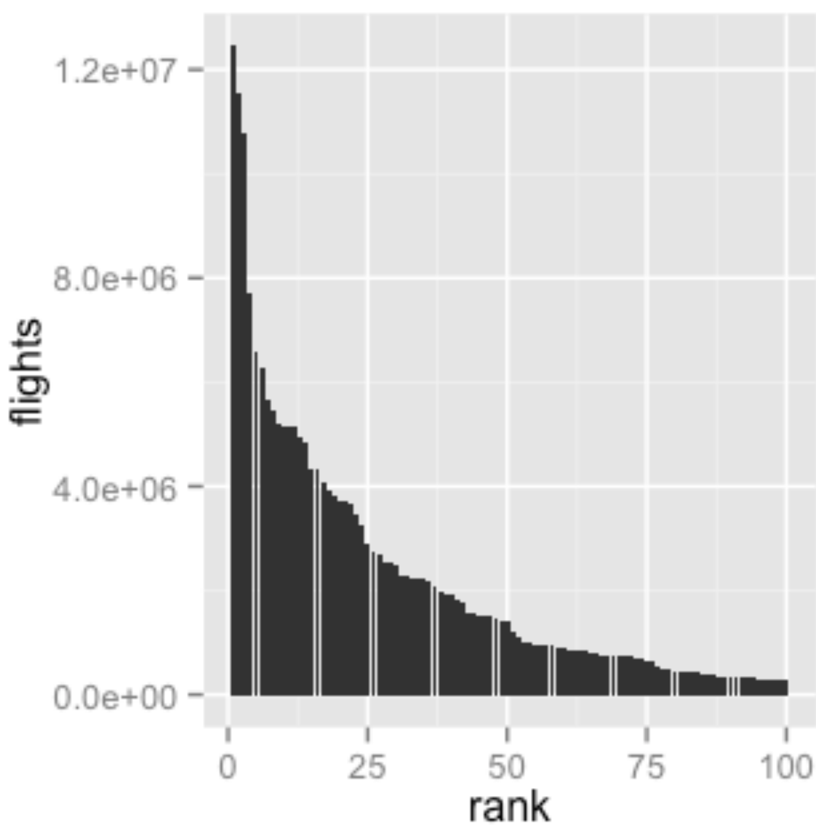
```
IND CMH CO  4.394163964798518
IND CMH NW  7.601538461538461
IND CMH US  7.838587981676098
IND CMH HP  7.990588235294117
IND CMH AA  8.25
IND CMH DL  12.629807692307692
IND CMH EA  13.065420560747663

DFW IAH UA  8.899408284023668
DFW IAH PA (1)  9.333333333333334
DFW IAH OO  9.736549165120593
DFW IAH CO  10.00064736160672
DFW IAH DL  10.204433400386542
DFW IAH EV  10.691978609625668
DFW IAH AA  12.147884747647687
DFW IAH XE  12.8929173693086
DFW IAH MQ  12.975917431192661

LAX SFO PS  5.830402722631877
LAX SFO TZ  6.238095238095238
LAX SFO F9  6.965310206804537
LAX SFO US  10.821992785172284
LAX SFO MQ  10.933456561922366
LAX SFO AA  12.465499230261711
LAX SFO NW  12.79028697571744
LAX SFO EV  13.39871382636656
LAX SFO DL  13.483850453526124
LAX SFO CO  14.001739130434782

JFK LAX UA  11.469386288506684
JFK LAX HP  14.865141955835963
JFK LAX AA  15.044821251483475
JFK LAX DL  16.631231597116457
JFK LAX PA (1)  17.09370780448285
JFK LAX TW  18.287762061126546

ATL PHX    FL   12.61
ATL PHX US  12.687394957983193
ATL PHX HP  13.367140921409215
ATL PHX DL  13.867261117830722
ATL PHX EA  14.008673469387755


CASSANDRA:

 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    CMI |  ORD |             MQ |            15.739
```

```
 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    IND |  CMH |             AA |              8.25
    IND |  CMH |             CO |            4.3942
    IND |  CMH |             DL |             12.63
    IND |  CMH |             EA |            13.065
    IND |  CMH |             HP |            7.9906
    IND |  CMH |             NW |            7.6015
    IND |  CMH |             US |            7.8386


 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    DFW |  IAH |             AA |            12.148
    DFW |  IAH |             CO |            10.001
    DFW |  IAH |             DL |            10.204
    DFW |  IAH |             EV |            10.692
    DFW |  IAH |             MQ |            12.976
    DFW |  IAH |             OO |            9.7365
    DFW |  IAH |         PA (1) |            9.3333
    DFW |  IAH |             UA |            8.8994
    DFW |  IAH |             XE |            12.893


 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    LAX |  SFO |             AA |            12.465
    LAX |  SFO |             CO |            14.002
    LAX |  SFO |             DL |            13.484
    LAX |  SFO |             EV |            13.399
    LAX |  SFO |             F9 |            6.9653
    LAX |  SFO |             MQ |            10.933
    LAX |  SFO |             NW |             12.79
    LAX |  SFO |             PS |            5.8304
    LAX |  SFO |             TZ |            6.2381
    LAX |  SFO |             US |            10.822


 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    JFK |  LAX |             AA |            15.045
    JFK |  LAX |             DL |            16.631
    JFK |  LAX |             HP |            14.865
    JFK |  LAX |         PA (1) |            17.094
    JFK |  LAX |             TW |            18.288
    JFK |  LAX |             UA |            11.469
```

```
 origin | dest | unique_carrier | arrival_delay_avg
--------+------+----------------+-------------------
    ATL |  PHX |             DL |            13.867
    ATL |  PHX |             EA |            14.009
    ATL |  PHX |             FL |             12.61
    ATL |  PHX |             HP |            13.367
    ATL |  PHX |             US |            12.687
```

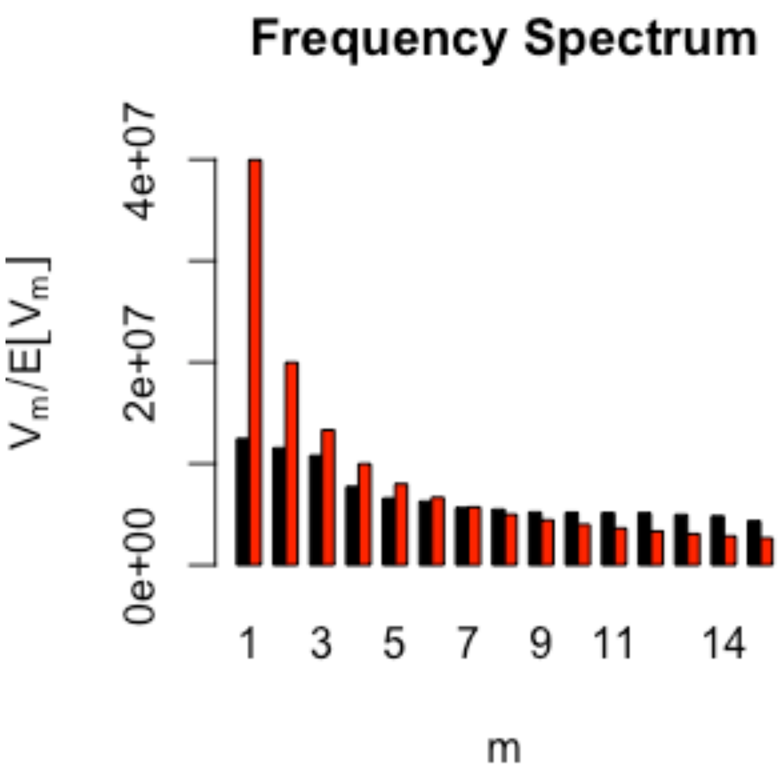
A.3.1 Does the popularity distribution of airports follow a Zipf distribution? If not, what distribution does it follow?

Zipf distributions are used in linguistics. Zipf's law states that given some corpus of natural language utterances, the frequency of any word is inversely proportional to its rank in the frequency table. As applied to airports in our problem, this means that the highest ranked airport should have roughly double the nunmber of flights as the second rated. The second rated should have double the third and so on. Our data when the number of flights looks very much like a zipf distribution. There is enough doubt about that bulge in the middle though (a typical zipf has an almost 90 degree elbow) to warrant some analysis.

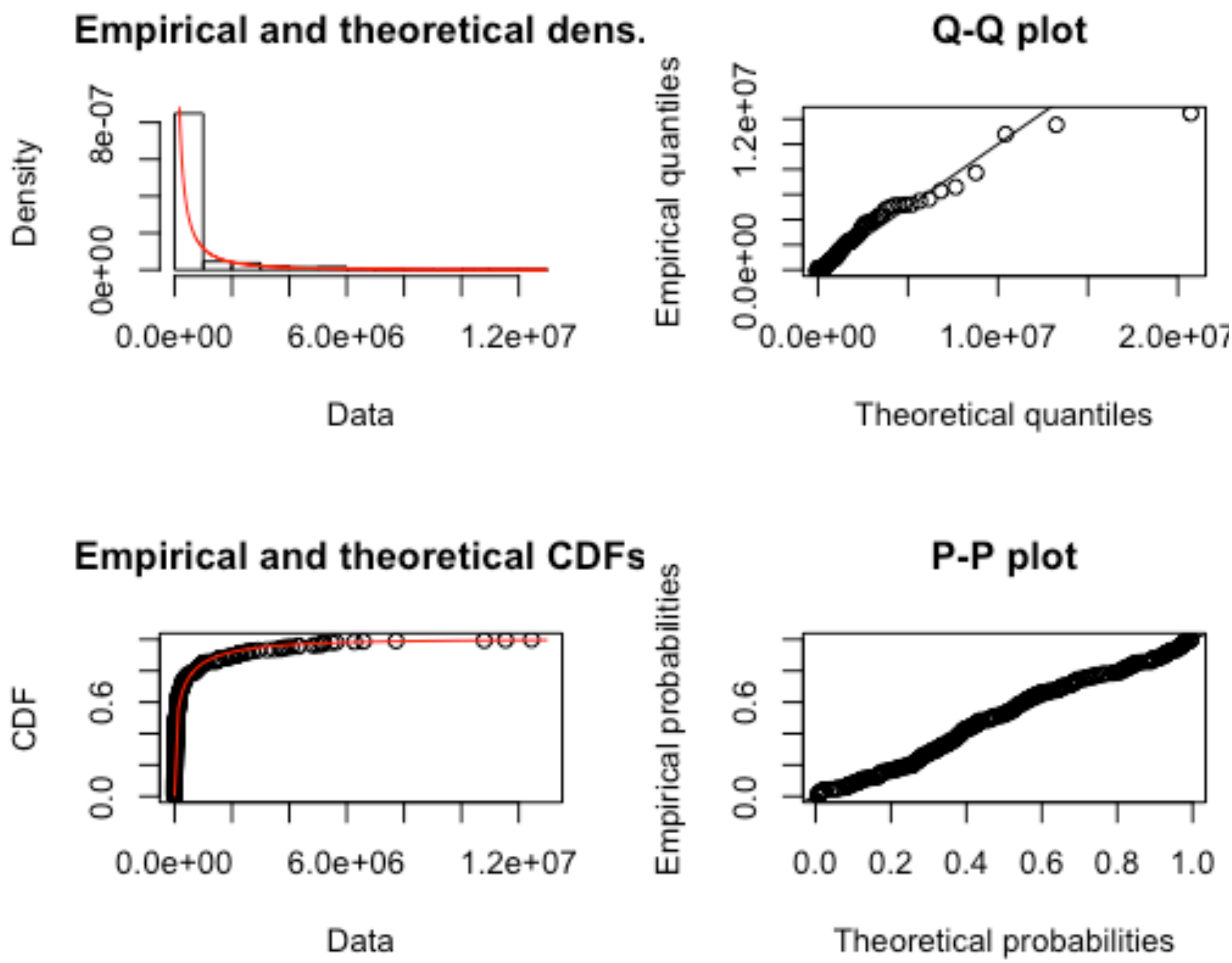


The zipfR R package allows you to compare your data against what a theoretical zipf distribution would look like if it had the same kind of bounds. When you run our data against the theoretical zipf, you see the problem that the most popular airports are not quite popular enough for a zipf.

```
## Warning in estimate.model.lnre.zm(model, spc = spc, param.names =
## missing.param, : estimated parameter values may be incorrect (code
3)
```



So what distribution does our data follow? The fitdistrplus R packages allows you to run various diagnostics against your data to determine which distribution it follows. It is a kind of trial and error approach, but the tools are nice enough that you can find a distribution. In our case, the data seem to fit a Weibull distribution almost perfectly.



A.3.2 Tom's Unusual Flight

```
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "CMI -> ORD Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
3206     4278    CMI  ORD      MQ 2008-04-03      706     0
3236     4373    CMI  ORD      MQ 2008-04-03      908     0
3265     4374    CMI  ORD      MQ 2008-04-03      557     0
3290     4401    CMI  ORD      MQ 2008-04-03      808     0
[1] ""
[1] "ORD -> LAX Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
```

```
3031      121    ORD  LAX      UA 2008-04-05     1219     0
3375      607    ORD  LAX      AA 2008-04-05     1948     0
3403      889    ORD  LAX      AA 2008-04-05     1815     0
3435     1345    ORD  LAX      AA 2008-04-05     1404     0
3463     1407    ORD  LAX      AA 2008-04-05     1213     0
3369      557    ORD  LAX      AA 2008-04-05     1641     6
3094      129    ORD  LAX      UA 2008-04-05     2102    12
3153      943    ORD  LAX      UA 2008-04-05     1506    12
3123      941    ORD  LAX      UA 2008-04-05     1712    19
3064      127    ORD  LAX      UA 2008-04-05     1847    20
3023      111    ORD  LAX      UA 2008-04-05     1208    38
[1] ""
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "JAX -> DFW Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
1545      845    JAX  DFW      AA 2008-09-09      722     1
[1] ""
[1] "DFW -> CRP Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
1493     3627    DFW  CRP      MQ 2008-09-11     1648     0
1521     3701    DFW  CRP      MQ 2008-09-11     1310     8
1438     3419    DFW  CRP      MQ 2008-09-11     1504     9
[1] ""
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "No flights found matching criteria X=SLC; Y=BFL; Z=LAX; DATE=2008-
01-04"
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "No flights found matching criteria X=LAX; Y=SFO; Z=PHX; DATE=2008-
12-07"
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "DFW -> ORD Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
5155     6441    DFW  ORD      OO 2008-10-06      920     0
5232     1104    DFW  ORD      UA 2008-10-06      655     0
5289     2268    DFW  ORD      AA 2008-10-06      920     0
5320     2320    DFW  ORD      AA 2008-10-06      556     0
5418     2328    DFW  ORD      AA 2008-10-06      812     0
5542     2336    DFW  ORD      AA 2008-10-06     1003     0
5604     2340    DFW  ORD      AA 2008-10-06     1047     0
5665     2344    DFW  ORD      AA 2008-10-06     1148     0
5356     2324    DFW  ORD      AA 2008-10-06      703     6
[1] ""
[1] "ORD -> DFW Flights"
```

```
[1] "==================="
     flightno origin dest carrier       date dep_time delay
5175      357    ORD  DFW      UA 2008-10-08     1658     0
5204      725    ORD  DFW      UA 2008-10-08     2016     0
5260       47    ORD  DFW      AA 2008-10-08     1919     0
5389     2325    ORD  DFW      AA 2008-10-08     1240     0
5451     2329    ORD  DFW      AA 2008-10-08     1332     0
5636     2341    ORD  DFW      AA 2008-10-08     1650     0
5692     2345    ORD  DFW      AA 2008-10-08     1754     0
5748     2357    ORD  DFW      AA 2008-10-08     1945     0
5776     2361    ORD  DFW      AA 2008-10-08     2100     0
5482     2331    ORD  DFW      AA 2008-10-08     1429     2
5138     5949    ORD  DFW      OO 2008-10-08     1529    11
5513     2333    ORD  DFW      AA 2008-10-08     1520    17
5721     2349    ORD  DFW      AA 2008-10-08     2024    94
5575     2337    ORD  DFW      AA 2008-10-08     1909   184
[1] ""
Moved: 'hdfs://sandbox.hortonworks.com:8020/user/root/output' to trash
at: hdfs://sandbox.hortonworks.com:8020/user/root/.Trash/Current
[1] "LAX -> ORD Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
1898      944    LAX  ORD      UA 2008-01-01      700     1
1831      110    LAX  ORD      UA 2008-01-01     1005     9
1957       88    LAX  ORD      AA 2008-01-01      853    11
1985      764    LAX  ORD      AA 2008-01-01      558    11
1802      106    LAX  ORD      UA 2008-01-01      856    12
2070     2276    LAX  ORD      AA 2008-01-01      631    12
2032     1372    LAX  ORD      AA 2008-01-01     1106    70
2055     1740    LAX  ORD      AA 2008-01-01      217   161
[1] ""
[1] "ORD -> JFK Flights"
[1] "==================="
     flightno origin dest carrier       date dep_time delay
2135      918    ORD  JFK      B6 2008-01-03     1853     0
1743     5366    ORD  JFK      OH 2008-01-03     1736     2
2133      908    ORD  JFK      B6 2008-01-03     1208     5
2134      916    ORD  JFK      B6 2008-01-03     1603    10
2103     2352    ORD  JFK      AA 2008-01-03     1708    18
1927     4138    ORD  JFK      MQ 2008-01-03     1425    28
1744     5466    ORD  JFK      OH 2008-01-03     1335   145
[1] ""
```