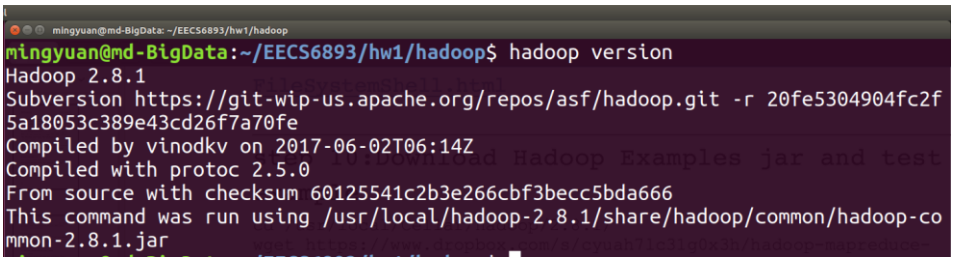
Hadoop Installation

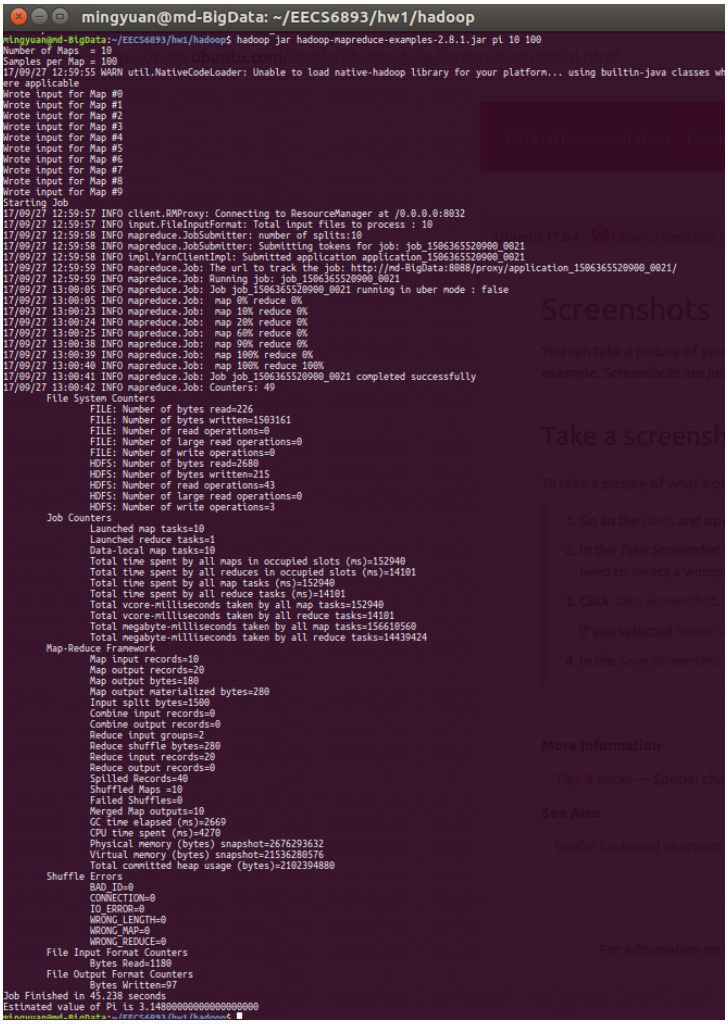
Hadoop version check

Run “$ Hadoop version” to ensure Hadoop is installed on VM and check its version.



Running Hadoop examples

1. Pi calculation



The result of Pi calculation given arguments “10 100” is 3.140000000000000000

2. Sudoku puzzle solution

```
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hadoop
 jar hadoop-mapreduce-examples-2.8.1.jar sudoku p
uzzle1.dta
Solving puzzle1.dta
8 5 1 3 9 2 6 4 7
4 3 2 6 7 8 1 9 5
7 9 6 5 1 4 3 8 2
6 1 4 8 2 3 7 5 9
5 7 8 9 6 1 4 2 3
3 2 9 4 5 7 8 1 6
9 4 7 2 8 6 5 3 1
1 8 5 7 3 9 2 6 4
2 6 3 1 4 5 9 7 8

Found 1 solutions
```

3. Wordcount
    a. Running word count job

```
an@md-BigData: ~/EECS6893/hw1/hadoop
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ clear

mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hdfs dfs -ls input
17/09/27 13:06:17 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Found 6 items
drwxr-xr-x   - mingyuan supergroup          0 2017-09-26 10:47 input/Bitcoin
drwxr-xr-x   - mingyuan supergroup          0 2017-09-26 19:20 input/Crime
drwxr-xr-x   - mingyuan supergroup          0 2017-09-26 19:16 input/HR
drwxr-xr-x   - mingyuan supergroup          0 2017-09-20 09:27 input/airline
drwxr-xr-x   - mingyuan supergroup          0 2017-09-20 16:01 input/dota2
-rw-r--r--   1 mingyuan supergroup     153241 2017-09-27 13:06 input/romeo_juliet.txt
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hadoop jar
airline/                        hadoop-mapreduce-examples-2.8.1.jar  puzzle1.dta
bitcoin/                        installation_check.sh                romeo_juliet.txt
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hadoop jar hadoop-mapreduce-examples-2.8.1.jar wordcount input/romeo_juliet.txt output/wordcount
17/09/27 13:07:01 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
17/09/27 13:07:02 INFO client.RMProxy: Connecting to ResourceManager at /0.0.0.0:8032
17/09/27 13:07:02 INFO input.FileInputFormat: Total input files to process : 1
17/09/27 13:07:02 INFO mapreduce.JobSubmitter: number of splits:1
17/09/27 13:07:02 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1506365520900_0022
17/09/27 13:07:03 INFO impl.YarnClientImpl: Submitted application application_1506365520900_0022
17/09/27 13:07:03 INFO mapreduce.Job: The url to track the job: http://md-BigData:8088/proxy/application_1506365520900_0022/
17/09/27 13:07:03 INFO mapreduce.Job: Running job: job_1506365520900_0022
17/09/27 13:07:09 INFO mapreduce.Job: Job job_1506365520900_0022 running in uber mode : false
17/09/27 13:07:09 INFO mapreduce.Job:  map 0% reduce 0%
17/09/27 13:07:14 INFO mapreduce.Job:  map 100% reduce 0%
17/09/27 13:07:19 INFO mapreduce.Job:  map 100% reduce 100%
17/09/27 13:07:19 INFO mapreduce.Job: Job job_1506365520900_0022 completed successfully
17/09/27 13:07:19 INFO mapreduce.Job: Counters: 49
        File System Counters
                FILE: Number of bytes read=84324
                FILE: Number of bytes written=441253
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=153364
                HDFS: Number of bytes written=59326
                HDFS: Number of read operations=6
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Launched map tasks=1
                Launched reduce tasks=1
                Data-local map tasks=1
                Total time spent by all maps in occupied slots (ms)=2408
                Total time spent by all reduces in occupied slots (ms)=2263
                Total time spent by all map tasks (ms)=2408
                Total time spent by all reduce tasks (ms)=2263
                Total vcore-milliseconds taken by all map tasks=2408
                Total vcore-milliseconds taken by all reduce tasks=2263
                Total megabyte-milliseconds taken by all map tasks=2465792
                Total megabyte-milliseconds taken by all reduce tasks=2317312
        Map-Reduce Framework
                Map input records=6052
                Map output records=25652
                Map output bytes=240799
                Map output materialized bytes=84324
                Input split bytes=123
                Combine input records=25652
                Combine output records=6342
                Reduce input groups=6342
                Reduce shuffle bytes=84324
                Reduce input records=6342
                Reduce output records=6342
                Spilled Records=12684
                Shuffled Maps =1
                Failed Shuffles=0
                Merged Map outputs=1
                GC time elapsed (ms)=125
                CPU time spent (ms)=1250
                Physical memory (bytes) snapshot=434724864
                Virtual memory (bytes) snapshot=3916529664
                Total committed heap usage (bytes)=331874304
        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=153241
        File Output Format Counters
                Bytes Written=59326
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$
```

    b. MapReduce job results

```
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hdfs dfs -ls output/
17/09/27 13:07:59 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where appl
icable
Found 3 items
drwxr-xr-x   - mingyuan supergroup          0 2017-09-20 16:28 output/airline
drwxr-xr-x   - mingyuan supergroup          0 2017-09-26 13:31 output/bitcoin
drwxr-xr-x   - mingyuan supergroup          0 2017-09-27 13:07 output/wordcount
mingyuan@md-BigData:~/EECS6893/hw1/hadoop$ hdfs dfs -ls output/wordcount
17/09/27 13:08:04 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where appl
icable
Found 2 items
-rw-r--r--   1 mingyuan supergroup          0 2017-09-27 13:07 output/wordcount/_SUCCESS
-rw-r--r--   1 mingyuan supergroup      59326 2017-09-27 13:07 output/wordcount/part-r-00000
```

```
mingyuan@md-BigData:~/EECS6893/hw1/hadoop/wordcount$ head part-r-00000
&       2
'       1
'An     1
'Ay     1
'Ay,'   1
'Ay.'   4
'By     1
'God    1
'Heart's        3
'Hold,  1
```

Datasets

1. Employee resign dataset

Column Metadata

satisfaction_level	Level of satisfaction (0-1)	Numeric
last_evaluation	Time since last performance evaluation (in Years)	Numeric
number_project	Number of projects completed while at work	Numeric
average_montly_hours	Average monthly hours at workplace	Numeric
time_spend_company	Number of years spent in the company	Numeric
Work_accident	Whether the employee had a workplace accident	Numeric
left	Whether the employee left the workplace or not (1 or 0) Factor	Numeric
promotion_last_5years	Whether the employee was promoted in the last five years	Numeric
sales	Department in which they work for	String
salary	Relative level of salary (high)	String

Preview (first 100 rows) Column Metadata

satisfaction_level	last_evaluation	number_project	average_montly_hours	time_spend_company	Work_accident	left	promotion_last_5years	sales	salary
0.38	0.53	2	157	3	0	1	0	sales	low
0.8	0.86	5	262	6	0	1	0	sales	medium
0.11	0.88	7	272	4	0	1	0	sales	medium
0.72	0.87	5	223	5	0	1	0	sales	low
0.37	0.52	2	159	3	0	1	0	sales	low
0.41	0.5	2	153	3	0	1	0	sales	low
0.1	0.77	6	247	4	0	1	0	sales	low
0.92	0.85	5	259	5	0	1	0	sales	low
0.89	1	5	224	5	0	1	0	sales	low
0.42	0.53	2	142	3	0	1	0	sales	low
0.45	0.54	2	135	3	0	1	0	sales	low
0.11	0.81	6	305	4	0	1	0	sales	low
0.84	0.92	4	234	5	0	1	0	sales	low
0.41	0.55	2	148	3	0	1	0	sales	low
0.36	0.56	2	137	3	0	1	0	sales	low
0.38	0.54	2	143	3	0	1	0	sales	low
0.45	0.47	2	160	3	0	1	0	sales	low
0.78	0.99	4	255	6	0	1	0	sales	low
0.45	0.51	2	160	3	1	1	1	sales	low
0.76	0.89	5	262	5	0	1	0	sales	low
0.11	0.83	6	282	4	0	1	0	sales	low
0.38	0.55	2	147	3	0	1	0	sales	low
0.09	0.95	6	304	4	0	1	0	sales	low

2. San Francisco crime dataset

This dataset contains incidents derived from SFPD Crime Incident Reporting system. The data ranges from 1/1/2003 to 5/13/2015. The training set and test set rotate every week, meaning week 1,3,5,7... belong to test set, week 2,4,6,8 belong to training set.

2003-01-07 07:52:00	WARRANTS	WARRANT ARREST	Tuesday	SOUTHERN	ARREST, BOOKED	5TH ST / SHIPLEY ST	-122.402843	37.779829
2003-01-07 04:49:00	WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	Tuesday	TENDERLOIN	ARREST, BOOKED	CYRIL MAGNIN STORTH ST / EDDY ST	-122.408495	37.784452
2003-01-07 03:52:00	WARRANTS	WARRANT ARREST	Tuesday	NORTHERN	ARREST, BOOKED	OFARRELL ST / LARKIN ST	-122.417904	37.785167
2003-01-07 03:34:00	WARRANTS	WARRANT ARREST	Tuesday	NORTHERN	ARREST, BOOKED	DIVISADERO ST / LOMBARD ST	-122.442650	37.798999
2003-01-07 01:22:00	WARRANTS	WARRANT ARREST	Tuesday	SOUTHERN	ARREST, BOOKED	900 Block of MARKET ST	-122.409537	37.782691
2003-01-06 23:30:00	WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	Monday	BAYVIEW	ARREST, BOOKED	REVERE AV / INGALLS ST	-122.384557	37.728487
2003-01-06 23:14:00	WARRANTS	WARRANT ARREST	Monday	CENTRAL	ARREST, BOOKED	BUSH ST / HYDE ST	-122.417019	37.789110
2003-01-06 22:45:00	WARRANTS	WARRANT ARREST	Monday	SOUTHERN	ARREST, BOOKED	800 Block of BRYANT ST	-122.403405	37.775421
2003-01-06 22:45:00	WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	Monday	SOUTHERN	ARREST, BOOKED	800 Block of BRYANT ST	-122.403405	37.775421
2003-01-06 22:19:00	WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	Monday	NORTHERN	ARREST, BOOKED	GEARY ST / POLK ST	-122.419740	37.785893
2003-01-06 21:54:00	WARRANTS	ENROUTE TO OUTSIDE JURISDICTION	Monday	NORTHERN	ARREST, BOOKED	SUTTER ST / POLK ST	-122.420120	37.787757

satisfaction_level	Level of satisfaction (0-1)	Numeric
last_evaluation	Time since last performance evaluation (in Years)	Numeric
number_project	Number of projects completed while at work	Numeric
average_montly_hours	Average monthly hours at workplace	Numeric
time_spend_company	Number of years spent in the company	Numeric
Work_accident	Whether the employee had a workplace accident	Numeric
left	Whether the employee left the workplace or not (1 or 0) Factor	Numeric
promotion_last_5years	Whether the employee was promoted in the last five years	Numeric
sales	Department in which they work for	String
salary	Relative level of salary (high)	String

3. Dota2 player ratings dataset

About this file

number of wins, number of matches, and TrueSkill rating computed from 900k matches. Each players rating is made up of a mean value and variance(mu, and sigma). The trueskill values were calculated using the python library `trueskill`, with default values. Kernel with details should be available soonish

account_id	total_wins	total_matches	trueskill_mu	trueskill_sigma
236579	14	24	27.86803545	5.212360755
-343	1	1	26.54416264	8.065475476
-1217	1	1	26.52110284	8.114989027
-1227	1	1	27.24802496	8.092216692
-1284	0	1	22.93101578	8.092224309
308663	1	1	26.76147599	8.108879564
79749	21	40	30.55341692	3.868734418
-1985	0	1	23.26340923	8.098020436
-2160	8	12	27.42601792	6.391300187
26500	26	50	27.94362078	4.04900453
-2776	0	1	23.05352155	8.110911377
137046	46	89	26.02599788	2.865184074
56881	15	23	32.85642397	5.132468772
-3110	1	2	25.49104138	7.846784863
-3126	0	1	23.28169403	8.119258685
221202	6	12	22.75076351	6.19852854
-3161	0	3	20.48337426	7.757888786
-3194	0	1	22.89152055	8.100930345
221204	3	8	21.29320658	6.560565351
-3421	2	4	23.66957648	7.481699509
-3477	2	2	28.53452152	7.728687255
-3596	6	9	27.43509115	6.591948751
-3602	0	2	22.56004551	7.951011533
-3682	7	11	26.49582281	6.474783609
120495	16	28	27.34034403	4.892810732
-3776	0	4	19.03829843	7.538703814
-3787	3	6	25.15808346	6.877262472
-3911	5	7	27.44244554	6.93831947
-3970	2	4	24.22086229	7.088620515

player_ratings

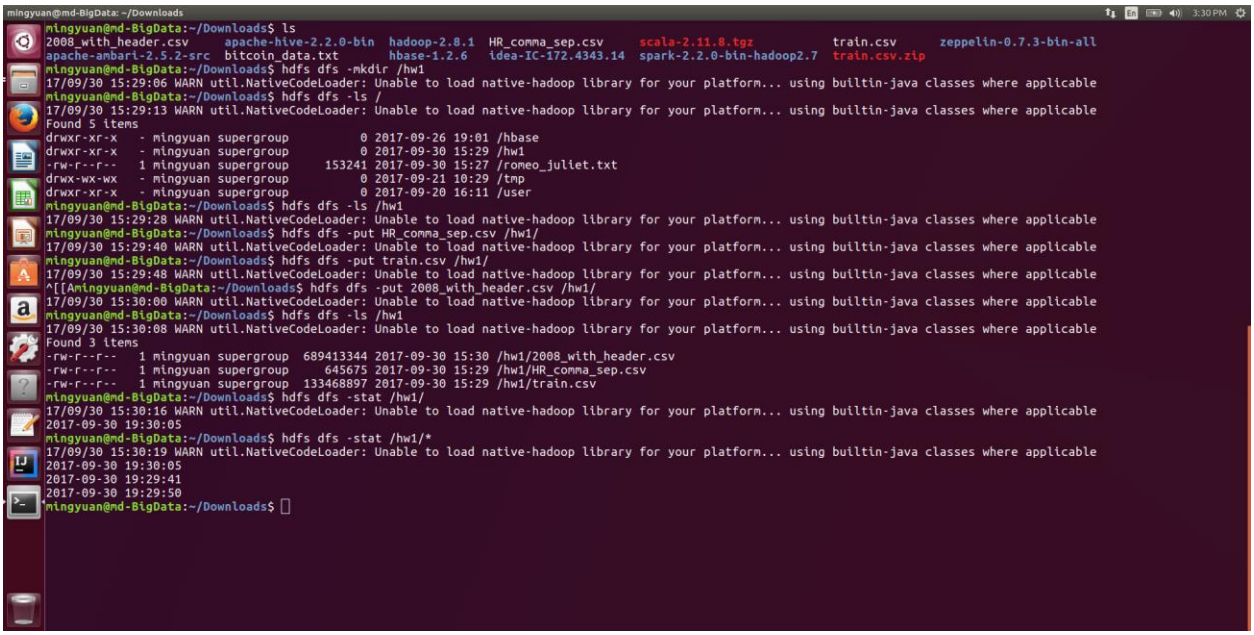
Hadoop Operation

1. -mkdir

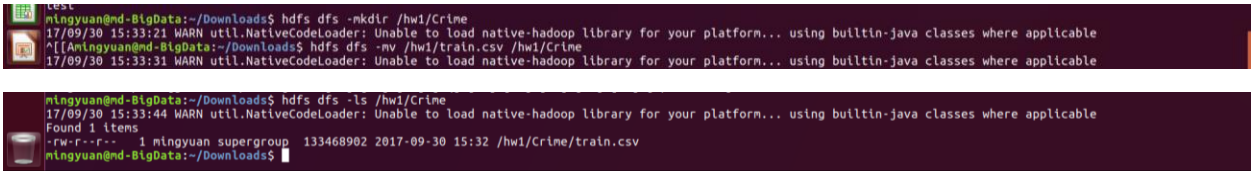
2. -ls

3. -put

4. -stat



5. -mv



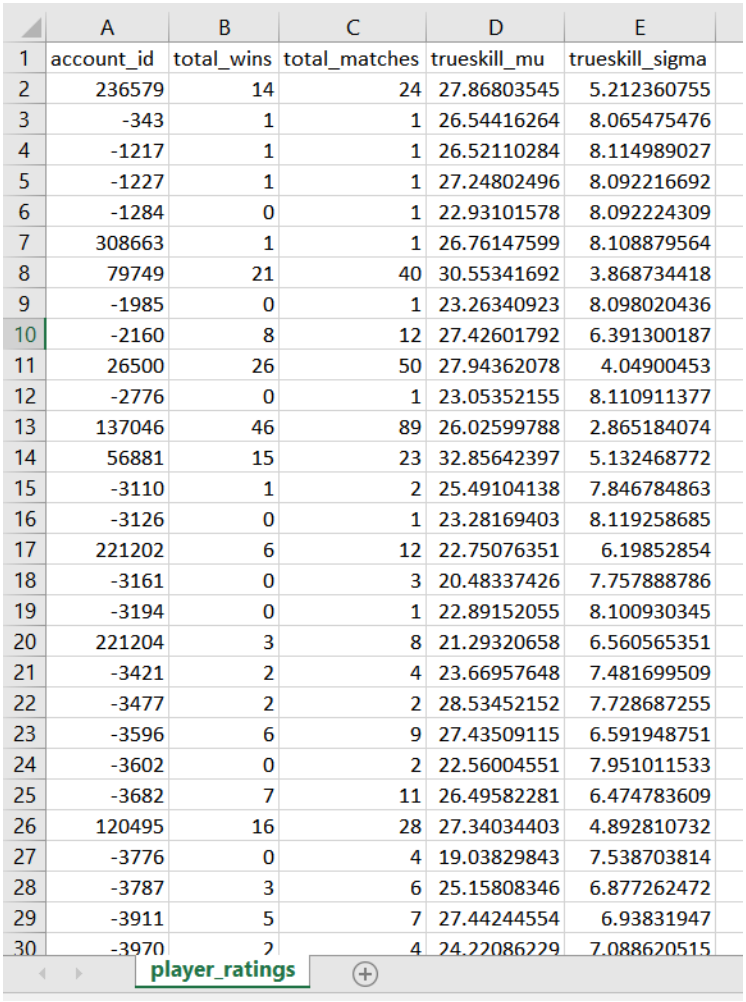
6. -appendToFile

7. -tail

Hbase query

Dota2 Dataset

1. Dataset example



	A	B	C	D	E
1	account_id	total_wins	total_matches	trueskill_mu	trueskill_sigma
2	236579	14	24	27.86803545	5.212360755
3	-343	1	1	26.54416264	8.065475476
4	-1217	1	1	26.52110284	8.114989027
5	-1227	1	1	27.24802496	8.092216692
6	-1284	0	1	22.93101578	8.092224309
7	308663	1	1	26.76147599	8.108879564
8	79749	21	40	30.55341692	3.868734418
9	-1985	0	1	23.26340923	8.098020436
10	-2160	8	12	27.42601792	6.391300187
11	26500	26	50	27.94362078	4.04900453
12	-2776	0	1	23.05352155	8.110911377
13	137046	46	89	26.02599788	2.865184074
14	56881	15	23	32.85642397	5.132468772
15	-3110	1	2	25.49104138	7.846784863
16	-3126	0	1	23.28169403	8.119258685
17	221202	6	12	22.75076351	6.19852854
18	-3161	0	3	20.48337426	7.757888786
19	-3194	0	1	22.89152055	8.100930345
20	221204	3	8	21.29320658	6.560565351
21	-3421	2	4	23.66957648	7.481699509
22	-3477	2	2	28.53452152	7.728687255
23	-3596	6	9	27.43509115	6.591948751
24	-3602	0	2	22.56004551	7.951011533
25	-3682	7	11	26.49582281	6.474783609
26	120495	16	28	27.34034403	4.892810732
27	-3776	0	4	19.03829843	7.538703814
28	-3787	3	6	25.15808346	6.877262472
29	-3911	5	7	27.44244554	6.93831947
30	-3970	2	4	24.22086229	7.088620515

player_ratings

2. Hbase queries
   a. Describe Hbase “PlayerRatings” table

```
-------------------------
1. describe 'PlayerRatings'
-------------------------
hbase(main):007:0> describe 'PlayerRatings'

Table PlayerRatings is ENABLED
PlayerRatings
COLUMN FAMILIES DESCRIPTION
{NAME => 'total_matches', BLOOMFILTER => 'ROW', VERSIONS => '1', IN_MEMORY => 'f
 alse', KEEP_DELETED_CELLS => 'FALSE', DATA_BLOCK_ENCODING => 'NONE', TTL => 'FOR
EVER', COMPRESSION => 'NONE', MIN_VERSIONS => '0', BLOCKCACHE => 'true', BLOCKSI
ZE => '65536', REPLICATION_SCOPE => '0'}
{NAME => 'total_wins', BLOOMFILTER => 'ROW', VERSIONS => '1', IN_MEMORY => 'fals
 e', KEEP_DELETED_CELLS => 'FALSE', DATA_BLOCK_ENCODING => 'NONE', TTL => 'FOREVE
R', COMPRESSION => 'NONE', MIN_VERSIONS => '0', BLOCKCACHE => 'true', BLOCKSIZE
=> '65536', REPLICATION_SCOPE => '0'}
{NAME => 'trueskill_mu', BLOOMFILTER => 'ROW', VERSIONS => '1', IN_MEMORY => 'fa
 lse', KEEP_DELETED_CELLS => 'FALSE', DATA_BLOCK_ENCODING => 'NONE', TTL => 'FORE
VER', COMPRESSION => 'NONE', MIN_VERSIONS => '0', BLOCKCACHE => 'true', BLOCKSIZ
E => '65536', REPLICATION_SCOPE => '0'}
{NAME => 'trueskill_sigma', BLOOMFILTER => 'ROW', VERSIONS => '1', IN_MEMORY =>
'false', KEEP_DELETED_CELLS => 'FALSE', DATA_BLOCK_ENCODING => 'NONE', TTL => 'F
 OREVER', COMPRESSION => 'NONE', MIN_VERSIONS => '0', BLOCKCACHE => 'true', BLOCK
SIZE => '65536', REPLICATION_SCOPE => '0'}
4 row(s) in 0.1390 seconds
```

b. Count total rows in “PlayerRatings” table and set INTERVAL to 100000

```
-----------------------
2.count 'PlayerRatings'
-----------------------

hbase(main):009:0> count 'PlayerRatings', INTERVAL => 100000
Current count: 100000, row: -120885589
Current count: 200000, row: -149265190
Current count: 300000, row: -190801670
Current count: 400000, row: -255433468
Current count: 500000, row: -70551592
Current count: 600000, row: 118655
Current count: 700000, row: 23721
Current count: 800000, row: 62009
834227 row(s) in 24.6220 seconds
```

c. Get 1 row from table

```
-------------------------
3. get 'PlayerRatings','1'
-------------------------
hbase(main):016:0> get 'PlayerRatings','1'
COLUMN                CELL
 total_matches:       timestamp=1506006301661, value=24
 total_wins:          timestamp=1506006301661, value=14
 trueskill_mu:        timestamp=1506006301661, value=26.232905478885414
 trueskill_sigma:     timestamp=1506006301661, value=4.854237724893719
4 row(s) in 0.0130 seconds
```

d. Get 1 element from table

```
----------------------------------------
4. get 'PlayerRating', '1', 'trueskill_mu'
----------------------------------------

hbase(main):008:0> get 'PlayerRatings', '1', 'trueskill_mu'
COLUMN                CELL
 trueskill_mu:        timestamp=1506006301661, value=26.232905478885414
1 row(s) in 0.0040 seconds
```

e. Put 1 row into table

```
----------------------------------------
5. put
----------------------------------------
hbase(main):001:0> get 'PlayerRatings','1000000'
COLUMN                CELL
0 row(s) in 0.2190 seconds

hbase(main):002:0> put 'PlayerRatings','1000000','total_matches', '0'
0 row(s) in 0.0970 seconds

hbase(main):003:0> get 'PlayerRatings','1000000'
COLUMN                CELL
 total_matches:       timestamp=1506303169804, value=0
 1 row(s) in 0.0150 seconds

hbase(main):006:0> put 'PlayerRatings','1000000','total_wins', '0'
0 row(s) in 0.0310 seconds

hbase(main):007:0> put 'PlayerRatings','1000000','trueskill_mu', '0'
0 row(s) in 0.0110 seconds

hbase(main):008:0> put 'PlayerRatings','1000000','trueskill_sigma', '0'
0 row(s) in 0.0310 seconds

hbase(main):009:0> get 'PlayerRatings','1000000'
COLUMN                CELL
 total_matches:       timestamp=1506303169804, value=0
 total_wins:          timestamp=1506303229672, value=0
 trueskill_mu:        timestamp=1506303240168, value=0
 trueskill_sigma:     timestamp=1506303243353, value=0
4 row(s) in 0.0080 seconds
```

Hive Query

Dota2 Dataset

1. Create table and load dataset

```
----------------
1. Create table
----------------
hive> CREATE TABLE IF NOT EXISTS dota2.PlayerRatings (account_id BIGINT, total_matches INT, total_wins INT, trueskill_mu FLOAT,
trueskill_sigma FLOAT)
    > COMMENT 'Player Ratings' ROW FORMAT DELIMITED FIELDS TERMINATED BY ','
    > LOCATION '/user/mingyuan/test';
OK
Time taken: 0.131 seconds
```

2. Select 5 players who have player more than 100 games

```
-----------------
2. Select rows
-----------------
hive> Select * FROM PlayerRatings WHERE total_matches > 100 limit 5;

OK
37018   137     262     25.410934       2.001894
1589    109     229     26.938852       2.0036588
4880    119     238     25.396338       2.1643844
168114  127     221     26.771683       2.2445276
19609   139     251     30.792833       1.6721019
Time taken: 2.552 seconds, Fetched: 5 row(s)
```

3. Row count

Let's see how many players out of 834227 have played more than 100 games.

```
---------------
3. Count rows
---------------

hive> SELECT COUNT(*) FROM PlayerRatings WHERE total_matches > 100;

WARNING: Hive-on-MR is deprecated in Hive 2 and may not be available in the future versions. Consider using a different execution engine
(i.e. spark, tez) or using Hive 1.X releases.
Query ID = mingyuan_20170925103105_7a1fbbf1-7e3b-479b-a397-a890cc1cf053
Total jobs = 1
Launching Job 1 out of 1
Number of reduce tasks determined at compile time: 1
In order to change the average load for a reducer (in bytes):
  set hive.exec.reducers.bytes.per.reducer=<number>
In order to limit the maximum number of reducers:
  set hive.exec.reducers.max=<number>
In order to set a constant number of reducers:
  set mapreduce.job.reduces=<number>
Starting Job = job_1506276692849_0002, Tracking URL = http://md-BigData:8088/proxy/application_1506276692849_0002/
Kill Command = /usr/local/hadoop-2.8.1/bin/hadoop job  -kill job_1506276692849_0002
Hadoop job information for Stage-1: number of mappers: 1; number of reducers: 1
2017-09-25 10:31:36,426 Stage-1 map = 0%,  reduce = 0%
2017-09-25 10:32:10,687 Stage-1 map = 100%,  reduce = 0%, Cumulative CPU 11.45 sec
2017-09-25 10:32:35,563 Stage-1 map = 100%,  reduce = 100%, Cumulative CPU 19.82 sec
MapReduce Total cumulative CPU time: 19 seconds 820 msec
Ended Job = job_1506276692849_0002
MapReduce Jobs Launched:
Stage-Stage-1: Map: 1  Reduce: 1   Cumulative CPU: 19.82 sec   HDFS Read: 41903928 HDFS Write: 103 SUCCESS
Total MapReduce CPU Time Spent: 19 seconds 820 msec
OK
682
Time taken: 92.607 seconds, Fetched: 1 row(s)
ECS6893/hw1/hive/queries.txt[+] [FORMAT=unix] [TYPE=TEXT] [POS=24,1][12%] 27/09/17 - 13:17
```

The answer is 682, which is a small number. It means only ~0.1% players in this dataset has played more than 100 games. Not as same as I expected.

4. More complex selection

```
4.
-----------------
hive> SELECT * FROM PlayerRatings WHERE total_matches > 100 AND trueskill_mu > 35 ORDER BY trueskill_mu DESC;


WARNING: Hive-on-MR is deprecated in Hive 2 and may not be available in the future versions. Consider using a different execution engine (i.e. spark, tez) or
using Hive 1.X releases.
Query ID = mingyuan_20170925103658_d58c33a2-a3d7-48ff-bf96-7d74495d5a57
Total jobs = 1
Launching Job 1 out of 1
Number of reduce tasks determined at compile time: 1
In order to change the average load for a reducer (in bytes):
  set hive.exec.reducers.bytes.per.reducer=<number>
In order to limit the maximum number of reducers:
  set hive.exec.reducers.max=<number>
In order to set a constant number of reducers:
  set mapreduce.job.reduces=<number>
Starting Job = job_1506276692849_0003, Tracking URL = http://md-BigData:8088/proxy/application_1506276692849_0003/
Kill Command = /usr/local/hadoop-2.8.1/bin/hadoop job  -kill job_1506276692849_0003
Hadoop job information for Stage-1: number of mappers: 1; number of reducers: 1
2017-09-25 10:37:34,972 Stage-1 map = 0%,  reduce = 0%
2017-09-25 10:37:41,664 Stage-1 map = 100%,  reduce = 0%, Cumulative CPU 3.22 sec
2017-09-25 10:37:48,160 Stage-1 map = 100%,  reduce = 100%, Cumulative CPU 4.7 sec
MapReduce Total cumulative CPU time: 4 seconds 700 msec
Ended Job = job_1506276692849_0003
MapReduce Jobs Launched:
Stage-Stage-1: Map: 1  Reduce: 1   Cumulative CPU: 4.7 sec   HDFS Read: 41904366 HDFS Write: 273 SUCCESS
Total MapReduce CPU Time Spent: 4 seconds 700 msec
OK
19042       121     180     41.005955   1.9438242
1409        102     145     37.70351    2.3888664
-279718288  111     145     36.831314   2.8243928
32006       116     158     35.152496   2.447601
Time taken: 51.361 seconds, Fetched: 4 row(s)
```

Select players who have played more than 100 games and have high trueskill score. This query only returned 4 players.

5. Group by number of games played

```
hive> SELECT ROUND(total_matches, -1), COUNT(*) FROM PlayerRatings GROUP BY ROUND(total_matches, -1);


WARNING: Hive-on-MR is deprecated in Hive 2 and may not be available in the future versions. Consider using a different execution engine (i.e. spark, tez) or using Hive 1.X releases.
Query ID = mingyuan_20170925104504_5d27f2ca-bdff-4afc-a843-601bdaaa717c
Total jobs = 1
Launching Job 1 out of 1
Number of reduce tasks not specified. Estimated from input data size: 1
In order to change the average load for a reducer (in bytes):
  set hive.exec.reducers.bytes.per.reducer=<number>
In order to limit the maximum number of reducers:
  set hive.exec.reducers.max=<number>
In order to set a constant number of reducers:
  set mapreduce.job.reduces=<number>
Starting Job = job_1506276692849_0008, Tracking URL = http://md-BigData:8088/proxy/application_1506276692849_0008/
Kill Command = /usr/local/hadoop-2.8.1/bin/hadoop job  -kill job_1506276692849_0008
Hadoop job information for Stage-1: number of mappers: 1; number of reducers: 1
2017-09-25 10:45:09,660 Stage-1 map = 0%,  reduce = 0%
2017-09-25 10:45:15,990 Stage-1 map = 100%,  reduce = 0%, Cumulative CPU 2.75 sec
2017-09-25 10:45:22,295 Stage-1 map = 100%,  reduce = 100%, Cumulative CPU 4.07 sec
MapReduce Total cumulative CPU time: 4 seconds 70 msec
Ended Job = job_1506276692849_0008
MapReduce Jobs Launched:
Stage-Stage-1: Map: 1  Reduce: 1   Cumulative CPU: 4.07 sec   HDFS Read: 41903461 HDFS Write: 738 SUCCESS
Total MapReduce CPU Time Spent: 4 seconds 70 msec
OK
0       677338
10      115818
20      22687
30      8393
40      3992
50      2229
60      1264
70      802
80      512
90      345
100     246
110     168
120     109
130     75
140     61
150     45
160     35
170     28
180     11
190     18
200     12
210     10
220     3
230     5
240     7
250     3
260     2
270     3
290     1
300     1
340     1
400     1
1608400 1
Time taken: 18.618 seconds, Fetched: 34 row(s)
```

6. Find the maximum trueskill score

```
----------------------
6. Maximum trueskill_mu
----------------------

hive> SELECT MAX(trueskill_mu) AS label FROM PlayerRatings;


WARNING: Hive-on-MR is deprecated in Hive 2 and may not be available in the future versions. Consider using a different execution engine
(i.e. spark, tez) or using Hive 1.X releases.
Query ID = mingyuan_20170925105042_e6231bf1-dcc5-4a25-b113-ac225fed7798
Total jobs = 1
Launching Job 1 out of 1
Number of reduce tasks determined at compile time: 1
In order to change the average load for a reducer (in bytes):
  set hive.exec.reducers.bytes.per.reducer=<number>
In order to limit the maximum number of reducers:
  set hive.exec.reducers.max=<number>
In order to set a constant number of reducers:
  set mapreduce.job.reduces=<number>
Starting Job = job_1506276692849_0009, Tracking URL = http://md-BigData:8088/proxy/application_1506276692849_0009/
Kill Command = /usr/local/hadoop-2.8.1/bin/hadoop job  -kill job_1506276692849_0009
Hadoop job information for Stage-1: number of mappers: 1; number of reducers: 1
2017-09-25 10:50:46,933 Stage-1 map = 0%,  reduce = 0%
2017-09-25 10:50:53,234 Stage-1 map = 100%,  reduce = 0%, Cumulative CPU 3.05 sec
2017-09-25 10:50:58,525 Stage-1 map = 100%,  reduce = 100%, Cumulative CPU 4.14 sec
MapReduce Total cumulative CPU time: 4 seconds 140 msec
Ended Job = job_1506276692849_0009
MapReduce Jobs Launched:
Stage-Stage-1: Map: 1  Reduce: 1   Cumulative CPU: 4.14 sec   HDFS Read: 41903199 HDFS Write: 109 SUCCESS
Total MapReduce CPU Time Spent: 4 seconds 140 msec
OK
48.825893
Time taken: 18.539 seconds, Fetched: 1 row(s)
```

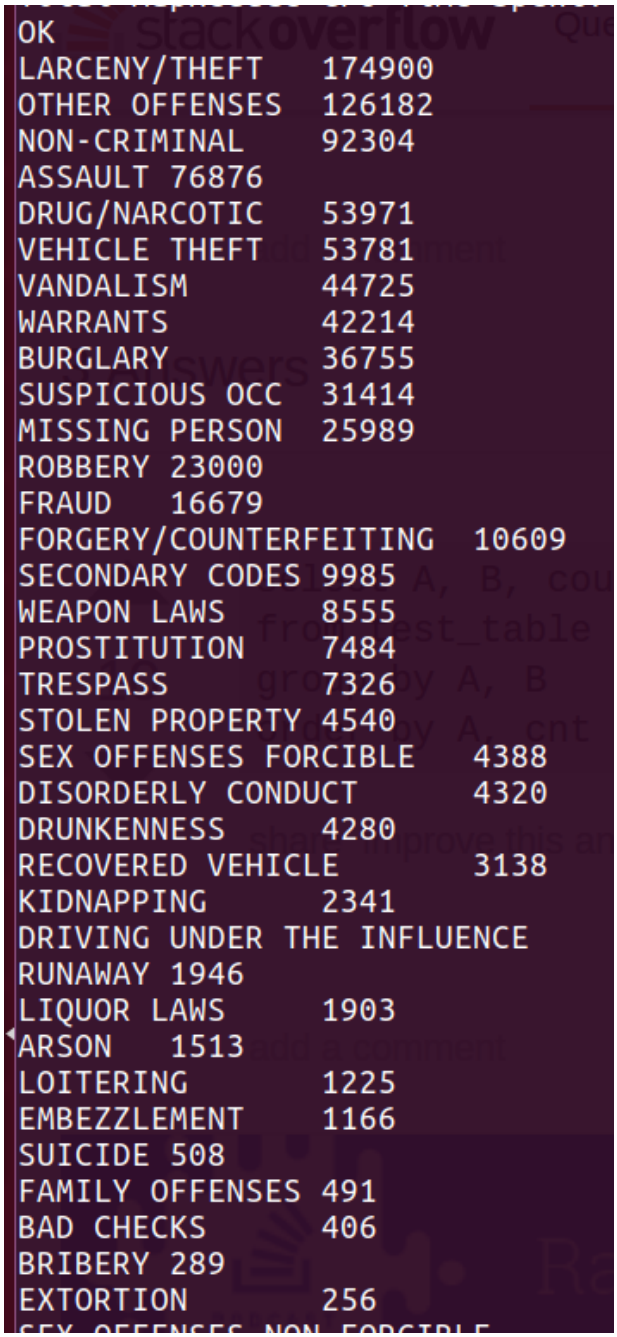
San Francisco Crime Dataset

1. Dataset Example

2	2015-05-13 23:53:00	WARRANTS	WARRANT ARREST	Wednesday	NORTHERN	"ARREST BOOKED"	NULL	-122.425891675136	
3	2015-05-13 23:53:00	OTHER OFFENSES	TRAFFIC VIOLATION ARREST	Wednesday	NORTHERN	"ARREST BOOKED"	NULL	-122.425891675136	
4	2015-05-13 23:33:00	OTHER OFFENSES	TRAFFIC VIOLATION ARREST	Wednesday	NORTHERN	"ARREST BOOKED"	NULL	-122.42436302145	
5	2015-05-13 23:30:00	LARCENY/THEFT	GRAND THEFT FROM LOCKED AUTO	Wednesday	NORTHERN	NONE	1500 Block of LOMBARD ST		-122.4269953267

2. Count crime numbers grouped by crime category

Query: SELECT Category, COUNT(*) AS cnt GROUP BY Category ORDER BY cnt DESC;



```
OK
LARCENY/THEFT   174900
OTHER OFFENSES  126182
NON-CRIMINAL    92304
ASSAULT 76876
DRUG/NARCOTIC   53971
VEHICLE THEFT   53781
VANDALISM       44725
WARRANTS        42214
BURGLARY        36755
SUSPICIOUS OCC  31414
MISSING PERSON  25989
ROBBERY 23000
FRAUD   16679
FORGERY/COUNTERFEITING  10609
SECONDARY CODES 9985
WEAPON LAWS     8555
PROSTITUTION    7484
TRESPASS        7326
STOLEN PROPERTY 4540
SEX OFFENSES FORCIBLE   4388
DISORDERLY CONDUCT      4320
DRUNKENNESS     4280
RECOVERED VEHICLE       3138
KIDNAPPING      2341
DRIVING UNDER THE INFLUENCE
RUNAWAY 1946
LIQUOR LAWS     1903
ARSON   1513
LOITERING       1225
EMBEZZLEMENT    1166
SUICIDE 508
FAMILY OFFENSES 491
BAD CHECKS      406
BRIBERY 289
EXTORTION       256
```

Airline Dataset Analysis

Hadoop

1. Hadoop Job
    a. Runner class

AirlineAnalysisRunner.java

```java
package EECS6893.airline;

import org.apache.hadoop.conf.Configured;


public class AirlineAnalysisRunner extends Configured implements Tool {
    public int run(String args[]) throws Exception {
        String inputDir = "input/airline/2008.csv";
        String outputDir1 = "output/airline/day_of_week";
        //String teamFight = "input/teamfights.csv";
        Job job = Job.getInstance();
        job.setJobName("test");
        job.setJarByClass(AirlineAnalysisRunner.class);
        //job.addCacheFile(new Path(teamFight).toUri());

        job.setMapperClass(AirlineMapper.class);
        job.setReducerClass(AirlineReducer.class);

        job.setInputFormatClass(TextInputFormat.class);
        TextInputFormat.addInputPath(job, new Path(inputDir));
        //job.getConfiguration().setInt("mapreduce.input.lineinputformat.linespermap", 1);
        FileOutputFormat.setOutputPath(job, new Path(outputDir1));
        job.setNumReduceTasks(1);

        job.setMapOutputKeyClass(IntWritable.class);
        job.setMapOutputValueClass(Text.class);
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(Text.class);

        return job.waitForCompletion(true) ? 0 : -1;

    }
    public static void main(String args[]) throws Exception {
        AirlineAnalysisRunner Dota2Driver = new AirlineAnalysisRunner();
        int res = ToolRunner.run(Dota2Driver, args);
        System.exit(res);

    }
}
```

    b. Mapper class

Eclipse

AirlineAnalysisRunner.java | AirlineMapper.java

```java
package EECS6893.airline;

import java.io.IOException;

public class AirlineMapper extends Mapper <LongWritable, Text, IntWritable
    public void map(LongWritable key, Text value, Context context) throws
        String[] airlines = value.toString().split(",");
        int dayOfWeek = Integer.parseInt(airlines[3]);
        context.write(new IntWritable(dayOfWeek), value);
    }

}
```

c. Reducer class

AirlineAnalysisRunner.java | AirlineMapper.java | *AirlineReducer.java

```java
package EECS6893.airline;

import java.io.IOException;

public class AirlineReducer extends Reducer <IntWritable, Text, Text, Text>{
    HashMap<Integer, String> res;

    public void reduce(IntWritable key, Iterable<Text> values, Context context) throws IOException, InterruptedException {
        if (res == null) res = new HashMap<Integer, String>();
        int sum = 0;
        int delayedNum = 0;
        int earlyNum = 0;
        int depDelayedNum = 0;
        int depEarlyNum = 0;
        int cancelledNum = 0;
        for (Text t: values) {
            String[] info = t.toString().split(",");

            if (!info[14].equals("NA")) {
                int delay = Integer.parseInt(info[14]);
                if (delay > 5) delayedNum++;
                else if (delay < -5) earlyNum++;
            }

            if (!info[15].equals("NA")) {
                int delay = Integer.parseInt(info[15]);
                if (delay > 5) depDelayedNum++;
                else if (delay < -5) depEarlyNum++;
            }

            if (info[21].equals("1")) cancelledNum++;


            sum++;

        }
        int day = key.get();

        String s = String.format("%-7d\t%-7d\t%2.1f%%\t%-7d\t%2.1f%%\t%-7d\t%2.1f%%\t%-7d\t%2.1f%%",
                                 sum,
                                 delayedNum, (double)delayedNum/sum * 100,
                                 depDelayedNum, (double)depDelayedNum/sum * 100,
                                 earlyNum, (double)earlyNum/sum * 100,
                                 depEarlyNum, (double)depEarlyNum/sum * 100);
        //context.write(new Text(String.valueOf(day)), new Text(s));
        res.put(day, s);
    }
```

2. Result

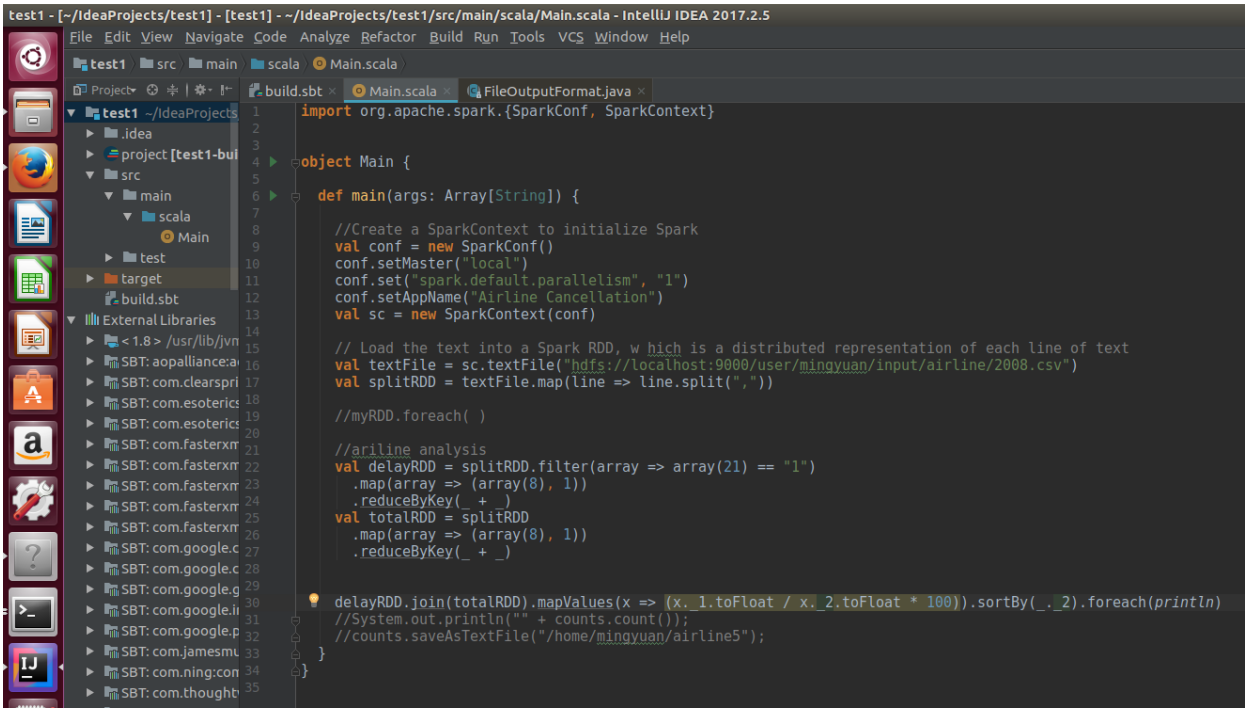
In this MapReduce job, I am trying to find the Airline delay corresponding to Day_Of_Week information. And it is obvious that airlines in Friday have higher arrive and departure delay rates. Also, we can see that around 40% of airlines arrived 5 mins earlier than expected arriving time, but only about 17% of airlines take off 5 mins earlier than scheduled departure time! It could be possible that many of the airline flying time is less than expected flying time and needs further investigate.

(~/EECS6893/hw1/hadoop/airline/day_of_week) - VIM

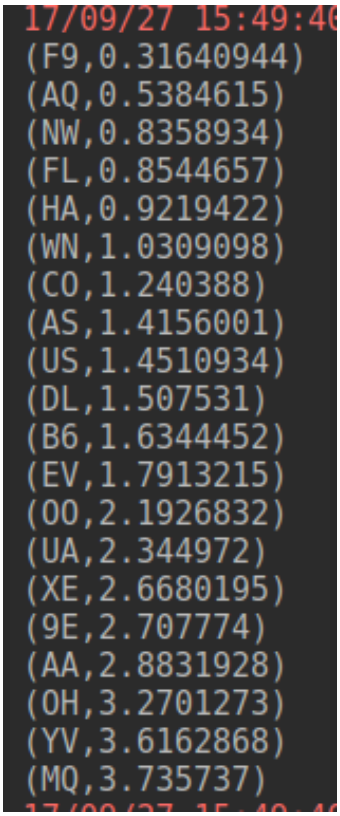
DoW	Sum	ArrDly	pct	DepDly	pct	ArrEly	pct	DepEly	pct
1	1036201	338725	32.7%	290933	28.1%	393371	38.0%	163385	15.8%
2	1032049	320368	31.0%	260943	25.3%	409879	39.7%	187414	18.2%
3	1039665	319652	30.7%	262805	25.3%	413096	39.7%	186823	18.0%
4	1032224	347551	33.7%	289451	28.0%	379414	36.8%	164186	15.9%
5	1035166	376409	36.4%	323259	31.2%	355542	34.3%	148018	14.3%
6	857536	254964	29.7%	223256	26.0%	364271	42.5%	150516	17.6%
7	976887	325379	33.3%	286111	29.3%	374324	38.3%	157544	16.1%

Spark

1. Spark job



2. Result



We can see the highest cancelation rate is Envoy Air(MQ)'3.7% and the lowest cancelation rate is Frontier Airline(F9)'s 0.32%, which is only one tenth of the highest rate. Delta has the lowest cancelation rate 1.51% comparing to the other two big airline companies America Airline (2.88%) and United Airline (2.34). So, Delta might be a better choice if you don't want your flying to be canceled.

Bitcoin Dataset Analysis

Hadoop

1. Hadoop Jobs

BitCoinRunner.java - Eclipse

BitcoinMapper.java | BitcoinReducer.java | BitCoinRunner.java

```java
package EECS6893.bitcoin;


import org.apache.hadoop.conf.Configured;


public class BitCoinRunner extends Configured implements Tool {
    public int run(String args[]) throws Exception {
        String inputDir = "input/Bitcoin/bitcoin_data.txt";
        String outputDir1 = "output/bitcoin";
        Job job = Job.getInstance();
        job.setJobName("bitcoin");
        job.setJarByClass(BitCoinRunner.class);

        job.setMapperClass(BitcoinMapper.class);
        job.setReducerClass(BitcoinReducer.class);

        job.setInputFormatClass(TextInputFormat.class);
        TextInputFormat.addInputPath(job, new Path(inputDir));
        //job.getConfiguration().setInt("mapreduce.input.lineinputformat.linespermap", 1);
        FileOutputFormat.setOutputPath(job, new Path(outputDir1));
        job.setNumReduceTasks(1);

        job.setMapOutputKeyClass(Text.class);
        job.setMapOutputValueClass(Text.class);
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(Text.class);

        return job.waitForCompletion(true) ? 0 : -1;

    }
    public static void main(String args[]) throws Exception {
        BitCoinRunner BitcoinDriver = new BitCoinRunner();
        int res = ToolRunner.run(BitcoinDriver, args);
        System.exit(res);

    }
}
```

/BitcoinMapper.java - Eclipse

BitcoinMapper.java | BitcoinReducer.java | BitCoinRunner.java

```java
package EECS6893.bitcoin;

import java.io.IOException;

public class BitcoinMapper extends Mapper <LongWritable, Text, Text, Text> {
    public void map(LongWritable key, Text value, Context context) throws IOException, InterruptedExceptior
        String[] bitcoinTrans = value.toString().split(",");

        String genderInfo = bitcoinTrans[5] + "->" +bitcoinTrans[6];
        if (!bitcoinTrans[5].equals("gender_from"))
            context.write(new Text(genderInfo), value);
    }

}
```

```
/BitcoinReducer.java - Eclipse
BitcoinMapper.java  *BitcoinReducer.java  BitCoinRunner.java  bitcoin_data.txt
 1 package EECS6893.bitcoin;
 2
 3
 4 import java.io.IOException;
11
12 public class BitcoinReducer extends Reducer <Text, Text, Text, Text>{
13
14     public void reduce(Text key, Iterable<Text> values, Context context) throws IOException, InterruptedExc
15         int num = 0;
16         long sum = 0;
17         for (Text t: values) {
18             num += 1;
19             String[] info = t.toString().split(",");
20             String amntS = info[info.length - 1];
21             double amnt = Double.parseDouble(amntS.substring(1, amntS.length()));
22             sum += amnt;
23
24         }
25         context.write(new Text(key),
26                 new Text(String.valueOf(num) + String.format("\t\t%.2f", (double)sum / num)));
27
28     }
29
30 }
```

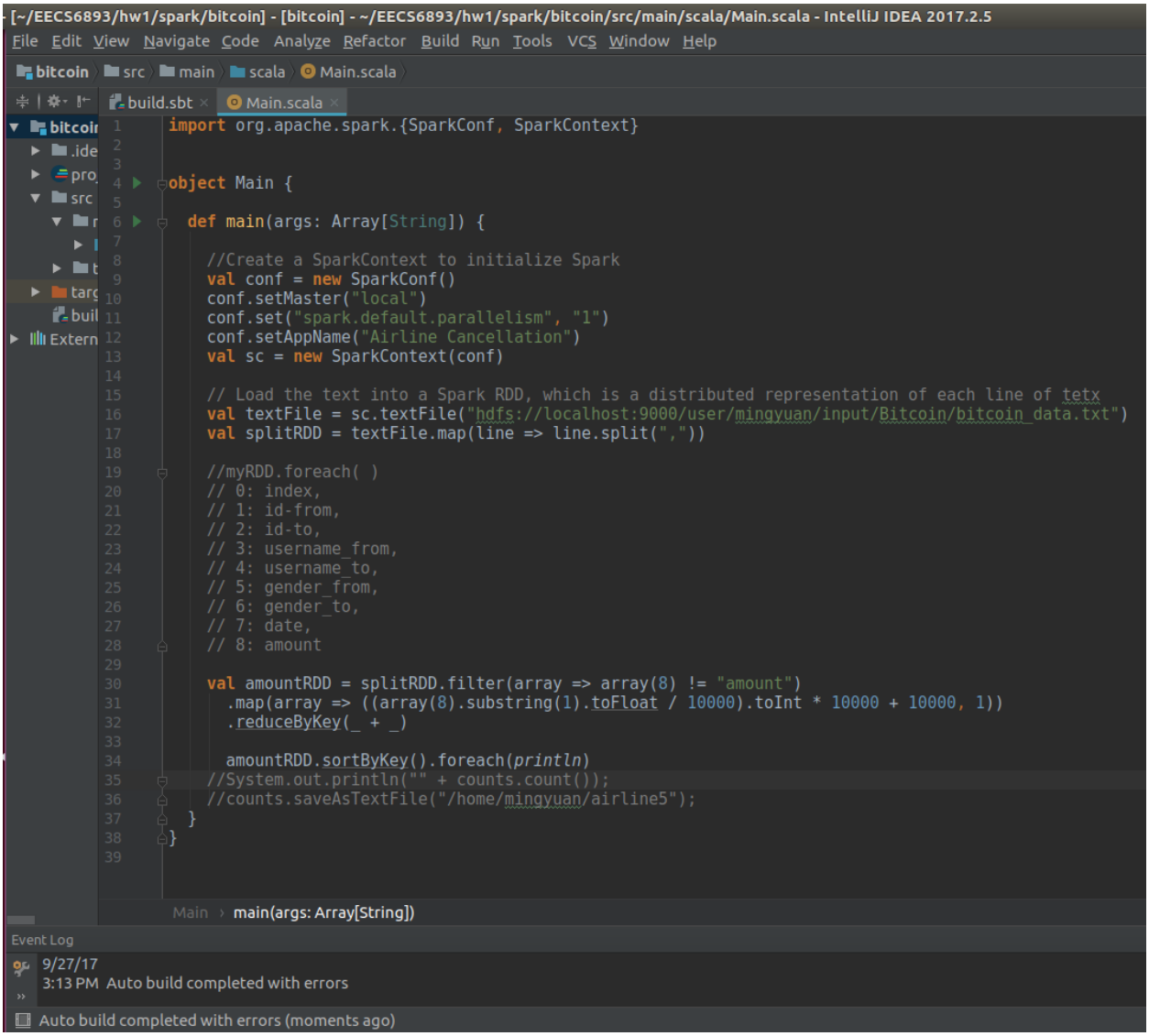
2. Result

```
ECS6893/hw1/hadoop/bitcoin/bitcoin) - VIM
Female->Female   12716   49425.42
Female->Male     12708   50057.24
Male->Female     12737   50130.55
Male->Male       12839   50227.80
```

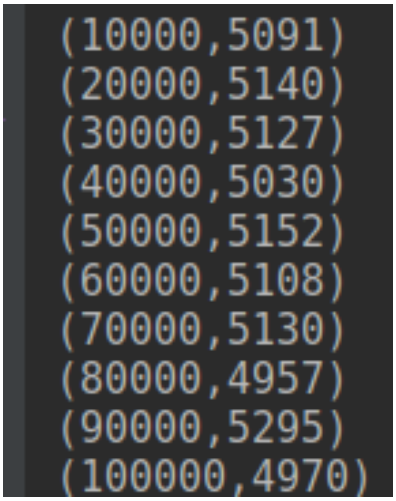
As we can see, the Hadoop MapReduce job output shows us the average amount of dollars in each transaction between genders. Female to female has the lowest average transaction amount 49425.42 and male to male has the highest average transaction amount 50227.80. Although the difference between genders is subtle (1.6% between F-F and M-M), this fact still shows that males tend to transact more amount of money in each transacation.

Spark

1. Spark job


[~/EECS6893/hw1/spark/bitcoin] - [bitcoin] - ~/EECS6893/hw1/spark/bitcoin/src/main/scala/Main.scala - IntelliJ IDEA 2017.2.5
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
bitcoin src main scala Main.scala
build.sbt Main.scala
import org.apache.spark.{SparkConf, SparkContext}
object Main {
def main(args: Array[String]) {
//Create a SparkContext to initialize Spark
val conf = new SparkConf()
conf.setMaster("local")
conf.set("spark.default.parallelism", "1")
conf.setAppName("Airline Cancellation")
val sc = new SparkContext(conf)
// Load the text into a Spark RDD, which is a distributed representation of each line of tetx
val textFile = sc.textFile("hdfs://localhost:9000/user/mingyuan/input/Bitcoin/bitcoin_data.txt")
val splitRDD = textFile.map(line => line.split(","))
//myRDD.foreach( )
// 0: index,
// 1: id-from,
// 2: id-to,
// 3: username_from,
// 4: username_to,
// 5: gender_from,
// 6: gender_to,
// 7: date,
// 8: amount
val amountRDD = splitRDD.filter(array => array(8) != "amount")
.map(array => ((array(8).substring(1).toFloat / 10000).toInt * 10000 + 10000, 1))
.reduceByKey(_ + _)
amountRDD.sortByKey().foreach(println)
//System.out.println("" + counts.count());
//counts.saveAsTextFile("/home/mingyuan/airline5");
}
}
Main › main(args: Array[String])
Event Log
9/27/17
3:13 PM Auto build completed with errors
Auto build completed with errors (moments ago)

2. Result


(10000,5091)
(20000,5140)
(30000,5127)
(40000,5030)
(50000,5152)
(60000,5108)
(70000,5130)
(80000,4957)
(90000,5295)
(100000,4970)

Here I want to investigate the amount of money in each bitcoin transaction. It seems that the amount of money in each transaction are almost evenly distributed from 0 ~ 90000 dollars given an interval of 10000, which is different from what I expected. My previous thought is that people are willing to do large amount transaction using bitcoin. And we can see that many people are using bitcoin to send large amount of money (~$100000).

Other analysis

Dota2 dataset linear regression

1. Load data
    a. Define schema

```
--------------
1. Load data
--------------

A. Define schema
---------------

scala> val id = StructField("account_id", IntegerType)
id: org.apache.spark.sql.types.StructField = StructField(account_id,IntegerType,true)

scala> val total_matches = StructField("total_matches", IntegerType)
total_matches: org.apache.spark.sql.types.StructField = StructField(total_matches,IntegerType,true)

scala> val total_wins = StructField("total_wins", IntegerType)
total_wins: org.apache.spark.sql.types.StructField = StructField(total_wins,IntegerType,true)

scala> val trueskill_mu = StructField("trueskill_mu", DoubleType)
trueskill_mu: org.apache.spark.sql.types.StructField = StructField(trueskill_mu,DoubleType,true)

scala> val trueskill_sigma = StructField("trueskill_sigma", DoubleType)
trueskill_sigma: org.apache.spark.sql.types.StructField = StructField(trueskill_sigma,DoubleType,true)

scala> val fields = Array(id, total_matches, total_wins, trueskill_mu, trueskill_sigma)
fields: Array[org.apache.spark.sql.types.StructField] = Array(StructField(account_id,IntegerType,true), StructField(total_matches,
IntegerType,true), StructField(total_wins,IntegerType,true), StructField(trueskill_mu,DoubleType,true), StructField(trueskill_sigma,
DoubleType,true))

scala> val schema = StructType(fields)
schema: org.apache.spark.sql.types.StructType = StructType(StructField(account_id,IntegerType,true), StructField(total_matches,
IntegerType,true), StructField(total_wins,IntegerType,true), StructField(trueskill_mu,DoubleType,true), StructField(trueskill_sigma,
DoubleType,true))
```

    b. Load Dota2 player rating data

```
B. Load Dota2 player rating data.
---------------------------------

scala> val df1 = spark.read.schema(schema).option("header", true).csv("hdfs://localhost:9000/user/mingyuan/pr/player_ratings.csv")
df1: org.apache.spark.sql.DataFrame = [account_id: int, total_matches: int ... 3 more fields]
```

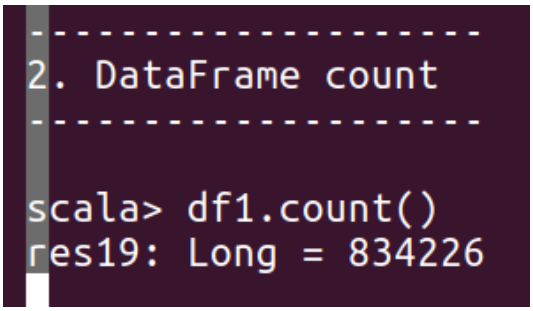
    c. Show data

```
C. Show data
-----------------

scala> df1.show
+----------+-------------+----------+------------------+------------------+
|account_id|total_matches|total_wins|     trueskill_mu|   trueskill_sigma|
+----------+-------------+----------+------------------+------------------+
|    236579|           14|        24| 27.86803544887669| 5.212360755154124|
|      -343|            1|         1| 26.54416264494717|  8.06547547571326|
|     -1217|            1|         1|26.521102844769825| 8.114989027066821|
|     -1227|            1|         1|27.248024958648585| 8.092216692198111|
|     -1284|            0|         1|22.931015779479623| 8.092224309040315|
|    308663|            1|         1|26.761475988284694| 8.108879563800533|
|     79749|           21|        40| 30.55341692111649|3.8687344175280614|
|     -1985|            0|         1|23.263409234993325| 8.098020435825411|
|     -2160|            8|        12|  27.4260179194793| 6.391300186726303|
|     26500|           26|        50| 27.94362077676565|4.0490045303341855|
|     -2776|            0|         1|23.053521554831327|   8.1109113767047|
|    137046|           46|        89| 26.02599787812959| 2.865184074214484|
|     56881|           15|        23| 32.85642396786685| 5.132468772471912|
|     -3110|            1|         2|25.491041376532355| 7.846784862628624|
|     -3126|            0|         1| 23.28169402641756|  8.11925868487977|
|    221202|            6|        12| 22.75076350501192| 6.198528539862464|
|     -3161|            0|         3|20.483374255793766| 7.757888786330731|
|     -3194|            0|         1| 22.89152055167358| 8.100930344663169|
|    221204|            3|         8|21.293206583904983| 6.560565350911063|
|     -3421|            2|         4| 23.66957648440773| 7.481699509258572|
+----------+-------------+----------+------------------+------------------+
only showing top 20 rows
```

d. Print schema

```
D. Print schema
--------------------

scala> df1.printSchema()
root
 |-- account_id: integer (nullable = true)
 |-- total_matches: integer (nullable = true)
 |-- total_wins: integer (nullable = true)
 |-- trueskill_mu: double (nullable = true)
 |-- trueskill_sigma: double (nullable = true)
```

2. DataFrame count



3. Spark SQL

```
3. Spark SQL
---------------

scala> df1.createOrReplaceTempView("dota2Player")

cala> val dedicatedPlayerDF = spark.sql("SELECT account_id,total_matches FROM dota2Player WHERE total_matches > 100 ORDER BY total_matches DESC")
dedicatedPlayerDF: org.apache.spark.sql.DataFrame = [account_id: int, total_matches: int]

scala> dedicatedPlayerDF.show()
+----------+-------------+
|account_id|total_matches|
+----------+-------------+
|         0|      1608398|
|      6647|          396|
|     12357|          341|
|     77866|          302|
|     35770|          290|
|      8101|          274|
|     17194|          271|
|     55446|          269|
|     28485|          262|
|     24722|          255|
|      2765|          251|
|    138306|          247|
|     52594|          245|
|     33769|          243|
|      3627|          241|
|     10069|          240|
|    116900|          240|
|     96383|          237|
|    297414|          237|
|    282413|          235|
+----------+-------------+
only showing top 20 rows
```

Select player who has played more than 100 games. There is a player who has played 1608398 which is impossible. Might be a problem caused by csv header.

4. Naïve Linear Regression
    a. Features assembler

```
-------------
4. Simple LR
-------------

A. Features assembler
--------------------------

scala> import org.apache.spark.ml.linalg.Vectors
import org.apache.spark.ml.linalg.Vectors

scala> val assembler = new VectorAssembler().setInputCols(Array("total_matches", "total_wins")).setOutputCol("features")
assembler: org.apache.spark.ml.feature.VectorAssembler = vecAssembler_b78134c8668f

scala> val featuresDF = assembler.transform(df1)
featuresDF: org.apache.spark.sql.DataFrame = [account_id: int, total_matches: int ... 4 more fields]

scala> featuresDF.show
+----------+-------------+----------+------------------+------------------+-----------+
|account_id|total_matches|total_wins|      trueskill_mu|   trueskill_sigma|   features|
+----------+-------------+----------+------------------+------------------+-----------+
|    236579|           14|        24| 27.86803544887669| 5.212360755154124|[14.0,24.0]|
|      -343|            1|         1| 26.54416264494717|  8.06547547571326|  [1.0,1.0]|
|     -1217|            1|         1|26.521102844769825| 8.114989027066821|  [1.0,1.0]|
|     -1227|            1|         1|27.248024958648585| 8.092216692198111|  [1.0,1.0]|
|     -1284|            0|         1|22.931015779479623| 8.092224309040315|  [0.0,1.0]|
|    308663|            1|         1|26.761475988284694| 8.108879563800533|  [1.0,1.0]|
|     79749|           21|        40| 30.55341692111649|3.8687344175280614|[21.0,40.0]|
|     -1985|            0|         1|23.263409234993325| 8.098020435825411|  [0.0,1.0]|
|     -2160|            8|        12|  27.4260179194793| 6.391300186726303| [8.0,12.0]|
|     26500|           26|        50| 27.94362077676565|4.0490045303341855|[26.0,50.0]|
|     -2776|            0|         1|23.053521554831327|   8.1109113767047|  [0.0,1.0]|
|    137046|           46|        89| 26.02599787812959| 2.865184074214484|[46.0,89.0]|
|     56881|           15|        23| 32.85642396786685| 5.132468772471912|[15.0,23.0]|
|     -3110|            1|         2|25.491041376532355| 7.846784862628624|  [1.0,2.0]|
|     -3126|            0|         1| 23.28169402641756|  8.11925868487977|  [0.0,1.0]|
|    221202|            6|        12| 22.75076350501192| 6.198528539862464| [6.0,12.0]|
|     -3161|            0|         3|20.483374255793766| 7.757888786330731|  [0.0,3.0]|
|     -3194|            0|         1| 22.89152055167358| 8.100930344663169|  [0.0,1.0]|
|    221204|            3|         8|21.293206583904983| 6.560565350911063|  [3.0,8.0]|
|     -3421|            2|         4| 23.66957648440773| 7.481699509258572|  [2.0,4.0]|
+----------+-------------+----------+------------------+------------------+-----------+
CS6893/hw1/spark/spark_shell_dota2/spark.txt [FORMAT=unix] [TYPE=TEXT] [POS=159,1][56%] 27/09/17 - 13:19
```

b. Change column names

```
ECS6893/hw1/spark/spark_shell_dota2) - VIM

B. Change column name
------------------------------

scala> val newN = Seq("id", " "," ","label", "", "features")
newN: Seq[String] = List(id, " ", " ", label, "", features)

scala> val lrDF=featuresDF.toDF(newN:_*)
lrDF: org.apache.spark.sql.DataFrame = [id: int,  : int ... 4 more fields]

scala> lrDF.show
+------+---+---+------------------+------------------+-----------+
|    id|   |   |             label|                  |   features|
+------+---+---+------------------+------------------+-----------+
|236579| 14| 24| 27.86803544887669| 5.212360755154124|[14.0,24.0]|
|  -343|  1|  1| 26.54416264494717|  8.06547547571326|  [1.0,1.0]|
| -1217|  1|  1|26.521102844769825| 8.114989027066821|  [1.0,1.0]|
| -1227|  1|  1|27.248024958648585| 8.092216692198111|  [1.0,1.0]|
| -1284|  0|  1|22.931015779479623| 8.092224309040315|  [0.0,1.0]|
|308663|  1|  1|26.761475988284694| 8.108879563800533|  [1.0,1.0]|
| 79749| 21| 40| 30.55341692111649|3.8687344175280614|[21.0,40.0]|
| -1985|  0|  1|23.263409234993325| 8.098020435825411|  [0.0,1.0]|
| -2160|  8| 12|  27.4260179194793| 6.391300186726303| [8.0,12.0]|
| 26500| 26| 50| 27.94362077676565|4.0490045303341855|[26.0,50.0]|
| -2776|  0|  1|23.053521554831327|   8.1109113767047|  [0.0,1.0]|
|137046| 46| 89| 26.02599787812959| 2.865184074214484|[46.0,89.0]|
| 56881| 15| 23| 32.85642396786685| 5.132468772471912|[15.0,23.0]|
| -3110|  1|  2|25.491041376532355| 7.846784862628624|  [1.0,2.0]|
| -3126|  0|  1| 23.28169402641756|  8.11925868487977|  [0.0,1.0]|
|221202|  6| 12| 22.75076350501192| 6.198528539862464| [6.0,12.0]|
| -3161|  0|  3|20.483374255793766| 7.757888786330731|  [0.0,3.0]|
| -3194|  0|  1| 22.89152055167358| 8.100930344663169|  [0.0,1.0]|
|221204|  3|  8|21.293206583904983| 6.560565350911063|  [3.0,8.0]|
| -3421|  2|  4| 23.66957648440773| 7.481699509258572|  [2.0,4.0]|
+------+---+---+------------------+------------------+-----------+
only showing top 20 rows
```

c. Split data into training set and validation set

```
C. Split data into traning data and validation data
-----------------------------------------------------

scala> val split = lrDF.randomSplit(Array(0.9,0.1))
split: Array[org.apache.spark.sql.Dataset[org.apache.spark.sql.Row]] = Array([id: int,  : int ... 4 more fields], [id: int,  : int ... 4 more fields])

scala> val train = split(0).cache()
train: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [id: int,  : int ... 4 more fields]

scala> val validation = split(1)
validation: org.apache.spark.sql.Dataset[org.apache.spark.sql.Row] = [id: int,  : int ... 4 more fields]
```

d. Train a simple LR model

```
D. Train a simple linear regression model
-------------------------------------------

scala> val model = lr.fit(train)
17/09/26 10:13:36 WARN optim.WeightedLeastSquares: regParam is zero, which might cause numerical instability and overfitting.
17/09/26 10:13:36 WARN netlib.BLAS: Failed to load implementation from: com.github.fommil.netlib.NativeSystemBLAS
17/09/26 10:13:36 WARN netlib.BLAS: Failed to load implementation from: com.github.fommil.netlib.NativeRefBLAS
17/09/26 10:13:38 WARN netlib.LAPACK: Failed to load implementation from: com.github.fommil.netlib.NativeSystemLAPACK
17/09/26 10:13:38 WARN netlib.LAPACK: Failed to load implementation from: com.github.fommil.netlib.NativeRefLAPACK
model: org.apache.spark.ml.regression.LinearRegressionModel = linReg_b23de0832693
```

e. Show results

```
E. Show results
---------------------

scala> model.transform(validation).show()
+----------+---+---+------------------+------------------+---------+------------------+
|        id|   |   |             label|                  | features|        prediction|
+----------+---+---+------------------+------------------+---------+------------------+
|-128396584|  1|  1|27.918812376134106| 8.053308860258714|[1.0,1.0]|25.636305865382393|
|-128396327|  2|  5|23.522165162753314| 7.258348927823103|[2.0,5.0]|24.238425636682162|
|-128391906|  1|  1|28.161518027242852| 8.019844081617187|[1.0,1.0]|25.636305865382393|
|-128385801|  3|  4|26.848128667469677| 7.370802079258343|[3.0,4.0]|26.445372362442924|
|-128384439|  0|  4|19.303048628447982| 7.534733942409549|[0.0,4.0]| 21.98742835783724|
|-128382256|  0|  2|22.554251369341607| 7.990255691229144|[0.0,2.0]|23.429359139621635|
|-128379426|  2|  2| 31.09536931318958|7.7954858068257025|[2.0,2.0]| 26.40132180935876|
|-128362765|  1|  3| 23.38138537665235| 7.533235212298229|[1.0,3.0]|24.194375083597997|
|-128357274|  0|  1| 23.54096127606779|  8.09166616855586|[0.0,1.0]|24.150324530513835|
|-128356857|  1|  2| 27.07600480063651|7.7138069904713555|[1.0,2.0]|24.915340474490197|
|-128356527|  1|  1| 26.14823703813555| 8.143672786544798|[1.0,1.0]|25.636305865382393|
|-128355496|  2|  3|26.589489067080606| 7.668522592115432|[2.0,3.0]| 25.68035641846656|
|-128353485|  3|  3|31.989149994214028|7.5491212159433845|[3.0,3.0]| 27.16633775333512|
|-128353222|  1|  1|28.025719800232352| 7.963141354806845|[1.0,1.0]|25.636305865382393|
|-128349146|  1|  4| 21.07936493484888| 7.441836835256949|[1.0,4.0]|  23.4734096927058|
|-128348482|  0|  2| 20.15261750242769| 7.784772142372692|[0.0,2.0]|23.429359139621635|
|-128344989|  2|  2|30.467669883864204| 7.754308395571972|[2.0,2.0]| 26.40132180935876|
|-128343728|  1|  1| 27.75372310889385| 8.029805259888121|[1.0,1.0]|25.636305865382393|
|-128338893|  2|  4|27.912820097659736|7.3226383507304025|[2.0,4.0]|24.959391027574362|
|-128336617|  2|  2|28.016630392213372| 7.967178037130402|[2.0,2.0]| 26.40132180935876|
+----------+---+---+------------------+------------------+---------+------------------+
only showing top 20 rows
```

Validation Set

```
scala> model.transform(train).show()
+----------+---+---+------------------+------------------+-----------+------------------+
|        id|   |   |             label|                  |   features|        prediction|
+----------+---+---+------------------+------------------+-----------+------------------+
|-128398173| 10| 27|   20.689088691544|5.0831419702521385|[10.0,27.0]|20.265037716002297|
|-128397829|  1|  3|24.065572096781725| 7.497539429075076|  [1.0,3.0]|24.194375083597997|
|-128397797|  1|  1| 26.97496663166592| 8.052270122623218|  [1.0,1.0]|25.636305865382393|
|-128397047|  0|  1|23.638990984594173| 8.106116057289787|  [0.0,1.0]|24.150324530513835|
|-128396750|  2|  3|26.630882351026454| 7.660736520814687|  [2.0,3.0]| 25.68035641846656|
|-128396552|  5|  7|27.736702156235467| 6.863038043612407|  [5.0,7.0]|27.254438859503452|
|-128395862|  0|  1|23.120203102063922|  8.02096736583166|  [0.0,1.0]|24.150324530513835|
|-128395592| 38| 59| 30.24520249380323|  3.69801583396422|[38.0,59.0]| 38.80162258377168|
|-128395541|  5| 11| 22.26825708994913| 6.428754519813465| [5.0,11.0]| 24.37057729593466|
|-128395390|  1|  1|28.334513967790194| 8.019769727806871|  [1.0,1.0]|25.636305865382393|
|-128395244|  1|  3|23.465269461896373| 7.612651710816195|  [1.0,3.0]|24.194375083597997|
|-128395197|  0|  5| 18.39246980228457| 7.365140373595669|  [0.0,5.0]|21.266462966945042|
|-128395082|  4|  4|32.202466398183304| 7.466894460617119|  [4.0,4.0]|27.931353697311486|
|-128395051|  0|  2| 21.32127820261808| 7.877511119478758|  [0.0,2.0]|23.429359139621635|
|-128394880|  1|  1|28.043870756278054|  7.97881206147458|  [1.0,1.0]|25.636305865382393|
|-128394278|  1|  1|28.228062271998144|7.9949827798162545|  [1.0,1.0]|25.636305865382393|
|-128393384|  2|  2|28.841544567657408|7.8666392457260095|  [2.0,2.0]| 26.40132180935876|
|-128393117|  0|  1| 23.05333232104851| 8.057701028697512|  [0.0,1.0]|24.150324530513835|
|-128392938|  1|  1|27.478545260286488| 7.962923344228324|  [1.0,1.0]|25.636305865382393|
|-128391577|  5| 13|20.851925696264416| 6.010443876522932| [5.0,13.0]|22.928646514150266|
+----------+---+---+------------------+------------------+-----------+------------------+
only showing top 20 rows
```

Training Set

Human Resource dataset decision tree prediction

1. Code

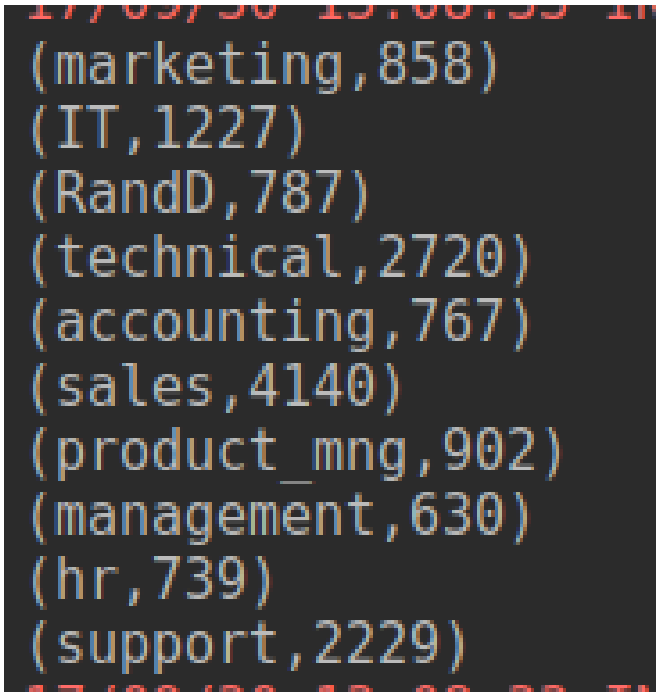
```
import org.apache.spark.{SparkConf, SparkContext}
import org.apache.spark.mllib.linalg.Vectors
import org.apache.spark.mllib.regression.LabeledPoint
import org.apache.spark.mllib.tree.DecisionTree
object Main {
 def main(args: Array[String]) {
  val conf = new SparkConf()
  conf.setMaster("local")
  conf.set("spark.default.parallelism", "1")
  conf.setAppName("HR")
  val sc = new SparkContext(conf)
  case class HR(id: Int,
          sat: Double,
          last_evl: Double,
          num_p: Int,
          amh: Int,
          tsc: Int,
          wa: Int,
          left: Int,
          pro: Int,
          sales: String,
          sala: String)
  def parseHR(str: String): HR = {
   val line = str.split(",")
   HR(line(0).toInt, line(1).toDouble, line(2).toDouble, line(3).toInt,
    line(4).toInt, line(5).toInt, line(6).toInt, line(7).toInt,
    line(8).toInt, line(9), line(10))
  }
  val textRDD =
sc.textFile("hdfs://localhost:9000/user/mingyuan/input/HR/HR_comma_sep.csv")
  val header = textRDD.first()
  val dropHeaderRDD = textRDD.filter(row => row != header)
  val hrRDD = dropHeaderRDD.map(parseHR).cache()
  val salesRDD = hrRDD.map(line => (line.sales, 1)).reduceByKey(_ + _)
  salesRDD.foreach(println)
  var salesMap: Map[String, Int] = Map()
  var index: Int = 0
  hrRDD.map(hr => hr.sales).distinct.collect.foreach(x => {
   salesMap += (x -> index);
   index += 1
```

```
  })
  println(salesMap.toString())
  var salaryMap: Map[String, Int] = Map()
  var index1: Int = 0
  hrRDD.map(hr => hr.sala).distinct.collect.foreach(x => {
   salaryMap += (x -> index1);
   index1 += 1
  })
  println(salaryMap.toString())
  val mlprep = hrRDD.map(hr => {
   val sat = hr.sat
   val eval = hr.last_evl
   val proj = hr.num_p
   val amh = hr.amh
   val tsc = hr.tsc
   val wa = hr.wa //category
   val left = hr.left //category
   val pro = hr.pro //category
   val sales = salesMap(hr.sales) //category
   val sala = salaryMap(hr.sala) //category
   Array(left.toDouble, sat.toDouble, eval.toDouble, proj.toDouble,
    amh.toDouble, tsc.toDouble, wa.toDouble, pro.toDouble, sales.toDouble,
sala.toDouble)
  })
  mlprep.take(10).foreach(println)
  val mldata = mlprep.map(x => LabeledPoint(x(0), Vectors.dense(x(1),
   x(2), x(3), x(4), x(5), x(6), x(7), x(8), x(9))))
  val mldata0 = mldata.filter(x => x.label == 0).randomSplit(Array(0.8, 0.2))(1)
  val mldata1 = mldata.filter(x => x.label != 0)
  val mldata2 = mldata0 ++ mldata1
  val splits = mldata2.randomSplit(Array(0.7, 0.3))
  val (trainingData, testData) = (splits(0), splits(1))
  var categoricalFeaturesInfo = Map[Int, Int]()
  categoricalFeaturesInfo += (5 -> 2)
  categoricalFeaturesInfo += (6 -> 2)
  categoricalFeaturesInfo += (7 -> salesMap.size)
  categoricalFeaturesInfo += (8 -> salaryMap.size)
  val numClasses = 2
  val impurity = "gini"
  val maxDepth = 9
  val maxBins = 5000
  val model = DecisionTree.trainClassifier(trainingData, numClasses,
categoricalFeaturesInfo, impurity, maxDepth, maxBins)
```

```
  println(model.toDebugString)
  val labelAndPreds = testData.map { point =>
   val prediction = model.predict(point.features)
   (point.label, prediction)
  }
  val res = labelAndPreds.map(x => ((x._1, x._1.equals(x._2)), 1))
   .reduceByKey(_ + _)
  res.collect().foreach(println)
 }
}
```

2. Result

a. Jobs summary



We can see that the job classes distribution is very similar to our intuition. The number of sales job is 4140, which is the most, comparing to the number management job 630.

b. Trained decision tree

Here I split the dataset into training data and test data, given the proportion 0.8,0.2. And I used the decision tree model from mllib to train a model to predict whether an employee quitted company or not given some data during his or her employment. The trained decision tree is like this:

```
  chooseSplits: 3.055918095
DecisionTreeModel classifier of depth 9 with 187 nodes
  If (feature 0 <= 0.46)
   If (feature 4 <= 4.0)
    If (feature 3 <= 121.0)
     Predict: 0.0
    Else (feature 3 > 121.0)
     If (feature 4 <= 2.0)
      If (feature 0 <= 0.14)
       If (feature 3 <= 214.0)
        Predict: 1.0
       Else (feature 3 > 214.0)
        Predict: 0.0
      Else (feature 0 > 0.14)
       If (feature 7 in {0.0,1.0,6.0,9.0,2.0,7.0})
        Predict: 0.0
       Else (feature 7 not in {0.0,1.0,6.0,9.0,2.0,7.0})
        If (feature 1 <= 0.46)
         Predict: 0.0
        Else (feature 1 > 0.46)
         If (feature 0 <= 0.36)
          If (feature 0 <= 0.21)
           Predict: 0.0
          Else (feature 0 > 0.21)
           Predict: 1.0
         Else (feature 0 > 0.36)
          If (feature 3 <= 171.0)
           Predict: 0.0
          Else (feature 3 > 171.0)
           Predict: 1.0
     Else (feature 4 > 2.0)
      If (feature 1 <= 0.42)
       Predict: 0.0
      Else (feature 1 > 0.42)
       If (feature 2 <= 2.0)
        If (feature 1 <= 0.57)
         If (feature 0 <= 0.32)
          If (feature 0 <= 0.29)
           Predict: 1.0
          Else (feature 0 > 0.29)
           Predict: 0.0
         Else (feature 0 > 0.32)
          If (feature 3 <= 161.0)
           Predict: 1.0
          Else (feature 3 > 161.0)
           Predict: 0.0
        Else (feature 1 > 0.57)
         If (feature 4 <= 3.0)
          Predict: 0.0
```

And the prediction accuracy is 95.4%