> Jiahui Tang

2.5. Meteorite Landing (10 points)

Develop a Spark version of the job to calculate the average mass per type of meteorite. You can use the `Meteorite_Landings.csv` dataset with 34,513 meteorites from Problem 1.5 downloaded from the NASA's Open Data Portal. You may need to use **DataFrames** to simplify the processing of the data.

```
$ spark-submit P25_spark.py
```

Submission

- `P25_spark.py`: Spark script
- `P25.pdf`: The command line that you used to execute the job and any information required to reproduce the execution

Command Used:

```
spark-submit P25_spark.py
```

Output:

```
recclass,avg(mass (g))
H5-an,25.95
H3.7-5,2048.3705
K,23.1
Howardite,652.0541249999999
CM2,368.3796159420287
C6,83.19999999999999
OC3,940.7624999999999
CK3.8,195.0
EL6,68.15
Enst achon-ung,3147.6666666666665
CK4,1276.9618
L4-melt rock,758.1
H3.7-6,97.8
"Iron, IVB",4322832.857142857
CO3.0,1150.16
Mesosiderite-A4,19166.666666666668
H6,862.3669882924697
L3.5-3.7,149.5
L3.3-3.7,15.4
Martian,9.3
Ureilite,490.0148999999998
"Iron, IC",892556.3
EL6/7,58150.0
R6,61.89111111111111
LL3.10,552.0666666666667
Eucrite-mmict,5963.286018518519
L3-6,3800.45625
Lunar (anorth),147.86782608695654
L6,30.348518518518524
LL3.2,4478.7300000000005
"Iron, IC-an",35000.0
LL<3.5,200.0
Stone-uncl,10750.528333333334
"Iron, ungrouped",422159.39858407073
H3-an,61.4
```

```
C1/2-ung,41.73
LL6-an,2730.0
Diogenite-pm,2209.5454545454545
L3.4,273.99509803921563
"Iron, IAB-an",2154.3333333333335
CO3.4,1415.594
CH3,74.0
L3.7-4,31.4
LL3.9/4,18.6
Eucrite,436.1987647058824
C4-ung,1749.3333333333333
Relict iron,0.0
EL-melt rock,8.3
H/L3.7,47.83
EH4,7701.782222222221
E5-an,9.77
EH4/5,39.288888888888884
L3.1,876.1438461538462
Howardite-an,494.0
H3.8-4,50000.0
H3.8-6,890.345
EL4/5,608.9
Aubrite-an,8390.77
L(LL)~4,331.0
L3.4-3.7,272.0
Lunar (gabbro),413.5316666666667
H3.15,730.0
L3-4,284.75
"Iron, IAB-sLH",7382.5666666666675
R4/5,184.0
H3.9-5,161.0
H3.5-4,167.3
Eucrite-an,6463.0
Lunar (bas/anor),5.585
L5-7,929.4
H3-5,1565.5741025641025
H3,796.0783782383425
H3/4,514.527457142857
L~3,362.7
Lunar (norite),633.0
H3.4-5,230.3
CO3.5,4799.423333333333
H(L)3,791.05
Martian (shergottite),879.0285353535351
CM1/2,175.79944444444445
"Iron, IIG",24303.166666666668
EH3,293.8635833333332
L~6,555.9021276595745
R3.8-6,266.55
H3.8/4,351.0
CV3-an,825.8
H~4/5,256.43333333333334
LL3.15,387.1033333333334
H3.9/4,5587.546
L3.00,81.0
H5/6,837.3940414507772
E4,42.6875
Ureilite-pmict,262.68565217391307
```

```
Impact melt breccia,172.0
LL3.7,3452.726538461539
C1-ung,""
LL3.05,128.0
Stone-ung,0.63
K3,180.5
Mesosiderite-C2,25613.0
CO3.6,1010.1183333333333
LL3,448.2764296875
H3.6-6,623.4
CM-an,66.0
E,57210.88428571429
L-imp melt,948.5056
LL-melt breccia,44.5061111111111
H4-5,747.8967446808512
H/L3,150.53333333333333
LL3-5,113.565
"Iron, IIE?",4.6
LL,103.2102222222222
H~6,791.4463636363636
H3.4/3.5,499.5
L5/6,2302.949357798165
LL3.6,4852.049411764707
C4/5,226.0
H5,831.5059090909091
L/LL4/5,789.2
L/LL-melt rock,23.2
LL3.5,390.4858823529412
L/LL4-6,3650.0
LL6-melt breccia,126.0
Achondrite-ung,895.8456140350878
Brachinite,565.040303030303
H/L3.9,7250.0
R3.8-5,174.0
L/LL~5,315.35
LL(L)3,995.2714285714285
CO3.3,4314.801428571429
"Iron, IIE-an",53137.04571428571
LL5-6,917.4825000000001
R3,87.74066666666666
Mesosiderite?,414.0
L(LL)3.05,491.54999999999995
H3.05,78.2
CK3/4,167.0
H3.2-3.7,17.7
LL3.8,603.8921428571429
LL~4/5,23.8
L4-melt breccia,5200.0
C4,28.97
CO3.1,303.31666666666666
Aubrite,67150.61333333336
"Iron, IID",67423.61578947368
Mesosiderite-A2,4949.0
Diogenite-olivine,747.5777777777778
CBa,44043.2
L3-5,945.6923076923077
L3.5,561.3556818181819
LL3/4,1452.0
```

```
H3-6,6941.4783720930245
LL6,155.595
H4/6,1493.0166666666664
L3.2,1153.7913333333336
H-metal,10.67
"Iron, IIC",26483.375
"Pallasite, ungrouped",7310.786
L3.9-5,31.94
H6,3.36
CH/CBb,16000.0
L/LL3-6,68.0
L3.05,231.15
LL(L)3.1,3200.0
L,3130.5900599999995
LL3.0,75.5575
R3-6,204.45
Iron,32316.30578947369
L3.2-3.6,65.3
L3.5-5,5590.0
"Iron, IAB-sHH",3862.2
Lunar (bas. breccia),79.0
H7,228.4666666666667
Eucrite-unbr,89.05875000000003
H3.5,838.1905555555555
"Iron, IID-an",11790.0
"Iron, IIIF",55777.26666666667
EH5,4654.038333333334
H/L3.6,28000.0
H3.2-6,83.9
Unknown,""
H3-4,9010.016
C3.0-ung,286.0
L-melt breccia,237.86999999999998
H3.7/3.8,208.6
Relict H,""
H-melt breccia,47.0925
Mesosiderite-A1,698206.3333333334
L3.10,404.0
L3.6-4,153.2
Martian (nakhlite),2058.714285714286
Chondrite-fusion crust,0.71
CR7,868.0
Eucrite-cm,2063.807692307692
Relict OC,0.0
CM2-an,12.7
"Iron, IIIAB",488805.9469718308
L/LL~6,700.9
CR1,57.550000000000004
H4-6,1615.7073134328357
Winonaite,1129.0132
L/LL6-an,5900.0
H-melt rock,121.83750000000002
H6/7,68.5
CR,271.8225
H3.0,182.85
L3/4,156.05916666666667
LL4,874.7136940298502
L3.8,828.0681818181819
```

```
EL3,135.74947368421053
LL~6,413.22200000000004
LL5-7,87.4
C,156.4475
LL7,200.23454545454544
R3.6,690.4666666666667
LL-imp melt,92.64999999999999
H/L4/5,96.8
Mesosiderite-A3,30666.666666666668
CO3.7,1600.0
CK6,103.32235294117648
L7,661.4038095238095
"Iron, IAB-sHL-an",762.0
L5-melt breccia,2198.6666666666665
L/LL3.5,32.4
L/LL,11.8
LL3.4,1283.8229999999999
"Iron, IAB-ung",686004.9673913044
Eucrite-br,179.68900000000002
H5-melt breccia,509.75
H(?)4,16.16
H5,2166.091410198939
R4,226.04619047619047
LL3.9,1586.9525
"Iron, IVA-an",73986.66666666667
L6-melt rock,22000.0
"Iron, IIIE-an",58400.0
H/L3.5,1001.0
L/LL5/6,350.8
L3.0-3.9,424.1
CK,120.73333333333333
E5,1.0979999999999999
H3.2,88.385
L3.8-an,14040.0
L3.5-3.8,73.0
EL5,593.9833333333333
Mesosiderite-B,2257.75
"Iron, IAB-sHL",9438.261176470589
CK5,131.56787234042554
CM,359.89000000000004
Lodranite-an,13.8
"Iron, IIIE",2076114.4285714286
L3.7/3.8,350.0
L4-6,70540.4712121212
R3.8,301.34666666666664
L3-melt breccia,1604.0
Martian (OPX),1930.9
Martian (basaltic breccia),200.0
H3,10.55
L3.7,1082.1699999999998
L3.3-3.6,203.3
L/LL3.2,1608.2
LL~4,28.7
Martian (chassignite),2305.5
L(LL)3.5-3.7,1228.1
H3.6,7203.912714285713
"Iron, IAB?",1582.75
R5,1359.824
```

```
R3-5,604.2166666666667
H3.4,652.2410625
"Iron, IIAB-an",59.0
L5,12.959047619047618
L/LL3.4,2994.5275
CO3.8,7901.666666666667
Enst achon,219.63333333333333
Mesosiderite-A,6234.75
L6,1450.4442837299246
H4/5,1601.5579088785053
H3.9-6,171.04749999999999
L3.3,442.1258823529412
EL4,234.9761538461539
H3.2-an,524.4333333333334
Eucrite-pmict,481.82130434782636
H/L~4,411.0
"Iron, IIE",42413.0
R3-4,171.0
EH-imp melt,82.70333333333335
LL3-6,2142.6355555555556
L3.7-6,6100.0
L3.9,1513.5466666666669
L/LL3.6/3.7,2618.0
H3.8-an,2135.5
"Iron, IAB complex",180809.19784313726
E3-an,25.666666666666668
L(H)3,65.7
"Iron, IAB-MG",1301547.2313253013
L~4,376.17999999999995
H/L5,289.5757142857143
"Iron, IIIAB-an",240233.33333333334
CM1,45.68578947368421
R,66.35333333333334
C2-ung,1129.1014285714286
L/LL5-6,3287.0
L(LL)6,265.0
Mesosiderite,4135.128588235292
Lunar (feldsp. breccia),500.5888888888889
H(L)3-an,271.0
LL5/6,162.35625
Acapulcoite/Lodranite,31.793333333333333
LL3-4,383.0
L6/7,5855.368888888889
E3,2.3876213592233024
R3.4,10.5
LL3.7-6,226.806
L(LL)3,55.86
H3.8/3.9,50.13
C3-ung,617.5666666666666
"Iron, IIF",11156.0
H3.8,1473.991052631579
H3.9,836.2806976744184
R3.7,236.0
EH7,2427.9
L3.5-3.9,325.8
LL6/7,533.75
L3.9-6,186.0
H-an,24.455000000000002
```

```
EH3/4-an,28.0
EH7-an,4720.0
Mesosiderite-C,34843.857142857145
Lunar (bas/gab brec),191.2
CR-an,114000.0
Iron?,2250.0
L3.9/4,402.0
R3.9,3055.7475
Diogenite,899.4614522821579
"Pallasite, PES",42167.5
L3.8-5,345.55
CO3,308.0
L/LL3.10,287.0
E6,345.2577777777778
L6-melt breccia,844.3399999999999
"Iron, IIIAB?",7795.5
L3.8-6,340.3333333333333
H5-6,2883.4873015873013
H3.1,187.60000000000002
H/L6,86.2209090909091
EL7,421.0
L3.2-3.5,351.7
CB,97.425
L3-7,122.25
L/LL3-5,413.76666666666665
L/LL3,357.93
Acapulcoite,490.4244074074073
L4/5,1666.98520338983
L3.0-3.7,50.1
L4-5,9275.753333333334
LL-melt rock,537.257142857143
Ureilite-an,1287.1250000000002
L3.6,1773.0595833333327
L5-6,8938.002195121951
CH3,223.7309523809524
C2,0.8
LL6,691.826736172296
H3.8-5,125.0
H5-7,3891.0
Fusion crust,0.07825000000000001
H/L4-5,1575.3
R3/4,80.65
H4-melt breccia,468.0
LL4-6,927.0535294117647
Lunar,536.849268292683
CK3-an,540.6
Lunar (basalt),1027.10875
LL~5,60.53222222222222
Angrite,1382.3700000000001
LL3.8-6,916.6666666666666
L3.7-3.9,1470.0
Mesosiderite-B4,359333.3333333333
L4,66.01333333333334
H~4,592.6888888888889
CK4-an,2932.6666666666665
"Iron, IIAB",322715.86017094017
EH6,92.94659999999999
LL4/5,873.78
```

```
L-melt rock,2268.984761904762
H/L3-4,2000.0
CR2-an,160.0
L/LL~4,23.6
C5/6-ung,169.2
LL3.1-3.5,80.1
H4,997.4195499881249
EL6,1993.532694444445
Mesosiderite-B1,1324.375
CI1,2390.192888888889
Diogenite-an,261.8666666666667
EL3/4,34.6
Pallasite,6319.560000000001
LL3.00,691.0
Acapulcoite/lodranite,44.93333333333334
H3.0-3.4,738.0
LL3.3,645.5566666666667
R3.5-4,248.0
C3/4-ung,12.0
Achondrite-prim,1078.0
Lodranite,268.9335
CBb,653.56
H3.10,330.0
L4,1635.8802490023959
L/LL6,12365.51076923077
CV2,30.6
L4-an,57.2
OC,3133.017534246575
H~5,820.3205405405408
L3.0,96.50500000000001
H-imp melt,11.860000000000001
H4,8.660000000000002
L~4-6,45.0
CO3,510.31995522387996
LL7(?),8.0
L~5,805.2615625000001
H/L6-melt rock,436.4
L/LL4,22547.43335
R3.5-6,205.0
LL3.1,1405.865
H3.7,3635.4982666666674
L(?)3,10.235
H3.3,414.2142857142857
"Iron, IVA",463545.47910447756
"Pallasite, PMG",147304.73684210525
"Iron, IAB-sLM",19816.1
L3,1534.4467863013706
L(LL)5,1056.0
Mesosiderite-A3/4,320000.0
H?,430.1
EH,0.59
L3.3-3.5,4.9
H4-an,312.90099999999995
H/L4,1456.9884615384615
Mesosiderite-B2,11857.342
Mesosiderite-an,2008.8166666666666
EH6-an,75.61
CR2,226.8968888888889
```

```
LL6(?),293.6
Eucrite-Mg rich,207.925
L-metal,1.0254
E-an,18.86
L/LL(?)3,2.0
"Iron, IAB-sLL",164194.64074074072
Chondrite-ung,997.562
H(5?),159.9
CV3,8953.690183593757
H6-melt breccia,332.4266666666667
H4(?),0.4
LL3.8-4,3500.0
L/LL5,39847.48125
CK3,214.65692307692308
LL4/6,35.0
"Pallasite, PMG-an",685358.9090909091
CK5/6,145.73333333333332
H,3537.492841463414
LL5,464.67588394793916
L5,1797.3517027534413
CO3.2,25598.88875
CK4/5,241.56583333333336
LL4-5,199.65
LL~3,19.866666666666664
Pallasite?,14180.0
```