

Dataset:

- **Source:** Bureau of Transportation Statistics, United States Department of Transportation
- **Dataset Link:**
https://www.transtats.bts.gov/OT_Delay/OT_DelayCause1.asp?20=E
- Number of features: 21
- Number of samples: 3351

Attributes:

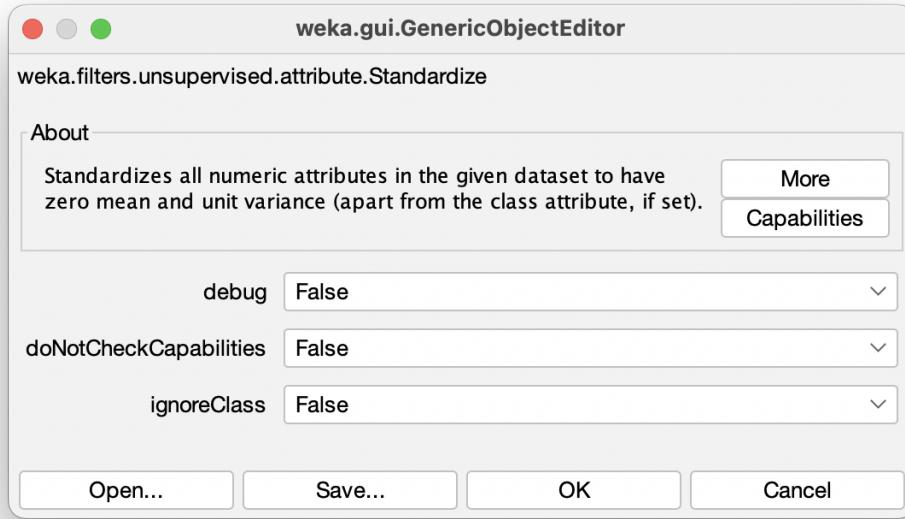
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Data before preprocessing:

Viewer														
No.	carrier	carrier_name	arr_flights	arr_del15	carrier_ct	weather_ct	nas_ct	security_ct	late_aircraft_ct	arr_cancelled	arr_diverted	late_aircraft_delay	carrier_delay	weather_delay
1	9E	Endeavor Air ...	44.0	3.0	1.63	0.0	0.12	0.0	1.25	0.0	1.0	89.0	56.0	0.0
2	9E	Endeavor Air ...	90.0	1.0	0.96	0.0	0.04	0.0	0.0	0.0	0.0	23.0	22.0	0.0
3	9E	Endeavor Air ...	88.0	8.0	5.75	0.0	1.6	0.0	0.65	0.0	1.0	338.0	265.0	0.0
4	9E	Endeavor Air ...	184.0	9.0	4.17	0.0	1.83	0.0	3.0	0.0	0.0	508.0	192.0	0.0
5	9E	Endeavor Air ...	76.0	11.0	4.78	0.0	5.22	0.0	1.0	1.0	0.0	692.0	398.0	0.0
6	9E	Endeavor Air ...	5985.0	445.0	142.89	11.96	161.37	1.0	127.79	5.0	0.0	30756.0	16390.0	1509.0
7	9E	Endeavor Air ...	142.0	14.0	5.36	0.0	7.7	0.0	0.94	1.0	0.0	436.0	162.0	0.0
8	9E	Endeavor Air ...	147.0	10.0	6.04	1.0	1.0	0.0	1.96	0.0	1.0	1070.0	838.0	141.0
9	9E	Endeavor Air ...	84.0	14.0	6.82	0.0	6.8	0.0	0.0	1.0	1.0	2006.0	1164.0	619.0
10	9E	Endeavor Air ...	150.0	19.0	5.7	0.0	12.07	0.0	1.23	3.0	0.0	846.0	423.0	0.0
11	9E	Endeavor Air ...	123.0	9.0	6.82	0.0	1.18	0.0	1.0	0.0	0.0	572.0	527.0	0.0
12	9E	Endeavor Air ...	25.0	7.0	0.34	0.0	3.54	0.0	3.11	2.0	0.0	278.0	13.0	0.0
13	9E	Endeavor Air ...	59.0	5.0	3.15	0.0	1.48	0.0	0.37	0.0	0.0	218.0	155.0	0.0
14	9E	Endeavor Air ...	2.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
15	9E	Endeavor Air ...	21.0	3.0	1.0	0.71	1.29	0.0	0.0	0.0	0.0	158.0	17.0	81.0
16	9E	Endeavor Air ...	90.0	6.0	3.8	0.0	1.63	0.0	0.57	0.0	0.0	374.0	249.0	0.0
17	9E	Endeavor Air ...	115.0	5.0	4.82	0.0	0.16	0.0	0.0	0.0	1.0	244.0	236.0	0.0
18	9E	Endeavor Air ...	90.0	10.0	3.06	0.85	5.4	0.0	0.68	0.0	0.0	759.0	220.0	258.0
19	9E	Endeavor Air ...	14.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	18.0	18.0	0.0
20	9E	Endeavor Air ...	17.0	8.5	0.0	5.11	0.0	0.0	3.4	1.0	0.0	1064.0	558.0	0.0
21	9E	Endeavor Air ...	106.0	5.0	3.7	0.0	1.3	0.0	0.0	0.0	0.0	230.0	205.0	0.0
22	9E	Endeavor Air ...	213.0	12.0	6.42	2.96	0.92	0.0	1.71	0.0	0.0	542.0	279.0	202.0
23	9E	Endeavor Air ...	86.0	1.0	0.59	0.0	0.0	0.0	0.41	1.0	1.0	17.0	10.0	0.0
24	9E	Endeavor Air ...	61.0	6.0	3.03	0.0	2.65	0.0	0.32	1.0	0.0	209.0	121.0	0.0
25	9E	Endeavor Air ...	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	9E	Endeavor Air ...	74.0	12.0	2.57	0.96	7.47	0.0	1.0	0.0	0.0	677.0	118.0	121.0
27	9E	Endeavor Air ...	42.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	64.0	64.0	0.0
28	9E	Endeavor Air ...	84.0	8.0	2.44	0.0	4.3	0.0	1.26	2.0	0.0	446.0	127.0	0.0

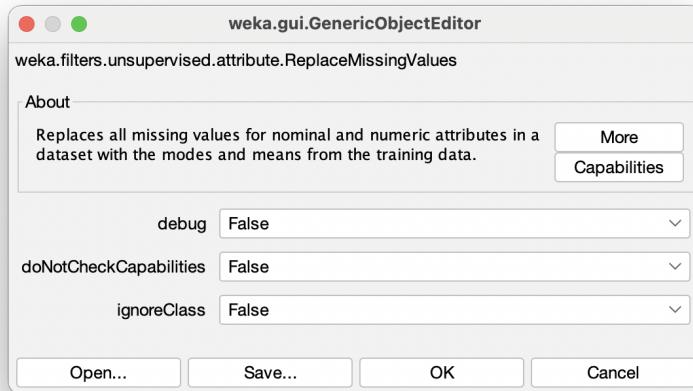
Add instance Undo OK Cancel

Data after standardisation:



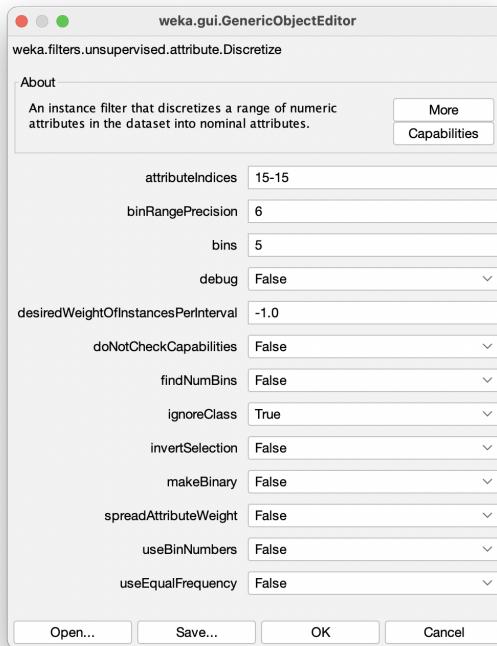
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2	-0.2418765...	-0.341300...	-0.361722...	-0.29930452...	-0.2861...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.321914604151334...	-0.3330550613...	-0.241836926274...	-0.23462694...	-0.198842374124...		
3	-0.2441500...	-0.290513...	-0.247017...	-0.29930452...	-0.2584...	-0.21241186...	-0.29787169545...	-0.2848456878...	0.202189447...	-0.291287256860217...	-0.2609716401...	-0.241836926274...	-0.22083604...	-0.198842374124...		
4	-0.1590227...	-0.266687...	-0.284853...	-0.29930452...	-0.2543...	-0.21241186...	-0.25548827618...	-0.2848456878...	-0.27448144...	-0.2747582192164274...	-0.2826564704...	-0.241836926274...	-0.20610485...	-0.198842374124...		
5	-0.2577909...	-0.273033...	-0.270245...	-0.29930452...	-0.1943...	-0.21241186...	-0.29155873003...	-0.1606964257...	-0.27448144...	-0.256867956321534...	-0.221518837...	-0.241836926274...	-0.17914990...	-0.198842374124...		
6	6.4592213...	2.6897378...	3.0370242...	2.18117030...	2.57318...	1.33442918...	1.99512769132...	0.2089006228...	-0.27448144...	2.6662447796332784...	4.52232832891...	1.813059609...	1.35101338...	3.390228847541...		
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8	-0.1770822...	-0.279860...	-0.240703...	-0.09190696...	-0.2690...	-0.21241186...	-0.27424491218...	-0.2848456878...	0.202189447...	-0.2021511418526791...	-0.090978248...	-0.049828701281...	-0.22741808...	-0.198842374124...		
9	-0.2486970...	-0.262553...	-0.235283...	-0.1020286...	-0.1663...	-0.21241186...	-0.30959395695...	-0.1606964257...	0.202189447...	-0.291287256860217...	-0.2609716401...	-0.241836926274...	-0.16504557...	-0.198842374124...		
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17	-0.2134579...	-0.313993...	-0.269287...	-0.29930452...	-0.2836...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.202189447...	-0.3004268475438821...	-0.2695743645...	-0.241836926274...	-0.23243293...	-0.198842374124...	
18	-0.2418765...	-0.279860...	-0.311434...	-0.12301659...	-0.1911...	-0.21241186...	-0.2973300264...	-0.2848456878...	-0.27448144...	-0.27448144...	-0.250353568571196...	-0.309497272648...	-0.16680673...	-0.198842374124...		
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21	-0.2236886...	-0.313993...	-0.296108...	-0.29930452...	-0.2637...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.3017880628945805...	-0.277701663...	-0.241836926274...	-0.22710463...	-0.198842374124...		
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25	-0.3316792...	-0.348127...	-0.364710...	-0.29930452...	-0.2686...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.3241508663196...	-0.3395811142...	-0.241836926274...	-0.23494037...	-0.198842374124...		
26	-0.260064...	-0.266607...	-0.323167...	-0.1020286...	-0.1544...	-0.21241186...	-0.29155873003...	-0.2848456878...	-0.27448144...	-0.2582626013401401...	-0.3045777394...	-0.0706931050...	-0.11019593...	-0.198842374124...		
27	-0.2964401...	-0.341300...	-0.360764...	-0.29930452...	-0.2886...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.31792817671467...	-0.32059662329...	-0.241836926274...	-0.23494037...	-0.198842374124...		
28	-0.2486970...	-0.293513...	-0.326280...	-0.29930452...	-0.2105...	-0.21241186...	-0.28686791703...	-0.0873471636...	-0.27448144...	-0.2807045426662...	-0.3019709904...	-0.241836926274...	-0.17338875...	-0.198842374124...		
29	-0.215731...	-0.293513...	-0.241030...	-0.09190696...	-0.2893...	-0.21241186...	-0.29444456633...	-0.2848456878...	-0.27448144...	-0.287592531381548...	-0.2491062893...	-0.21187191619...	-0.23243293...	-0.198842374124...		
30	-0.2316458...	-0.307167...	-0.326041...	-0.09812888...	-0.2410...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.303839968031258...	-0.3176298452...	-0.196889831063...	-0.217701717...	-0.198842374124...		
31	0.0889155...	-0.064580...	-0.238875...	-0.0234567...	0.13445...	-0.21241186...	-0.09641757474...	0.1101513605...	-0.27448144...	-0.159929977418230...	-0.2755071399...	-0.105660880...	-0.02024110...	-0.198842374124...		
32	-0.2441500...	-0.262553...	-0.237199...	-0.29930452...	-0.1836...	-0.21241186...	-0.27316279857...	-0.0873471636...	-0.27448144...	-0.249770190564321...	-0.252592592321...	-0.15815012...	-0.198842374124...			
33	-0.2998504...	-0.307167...	-0.382555...	-0.29930452...	-0.2201...	-0.21241186...	-0.27081821907...	-0.2848456878...	-0.27448144...	-0.283314425992245...	-0.3380979204...	-0.241836926274...	-0.14216521...	-0.198842374124...		
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36	-0.2498337...	-0.290513...	-0.348790...	-0.29930452...	-0.1911...	-0.21241186...	-0.28975520734...	-0.2848456878...	-0.27448144...	-0.280086172834068...	-0.2998515190...	-0.241836926274...	-0.15344868...	-0.198842374124...		
37	-0.279860...	-0.2702006...	-0.29930452...	-0.2756...	-0.21241186...	-0.22699621765...	-0.2848456878...	-0.27448144...	-0.279093652004336...	-0.2670272053...	-0.241836926274...	-0.22961207...	-0.198842374124...			
38	-0.2055007...	-0.273033...	-0.242467...	-0.29930452...	-0.2155...	-0.21241186...	-0.29083732095...	0.0114020984...	-0.27448144...	-0.2590070090154893...	-0.221518837...	-0.241836926274...	-0.16974701...	-0.198842374124...		
39	-0.0804590...	-0.156980...	-0.191940...	0.45354862...	-0.0993...	-0.21241186...	-0.20607175442...	0.4063991468...	-0.27448144...	-0.0608785983986444...	-0.1719802091...	3.340954845649...	-0.10706109...	-0.198842374124...		

Data after replacing missing values with means and modes:



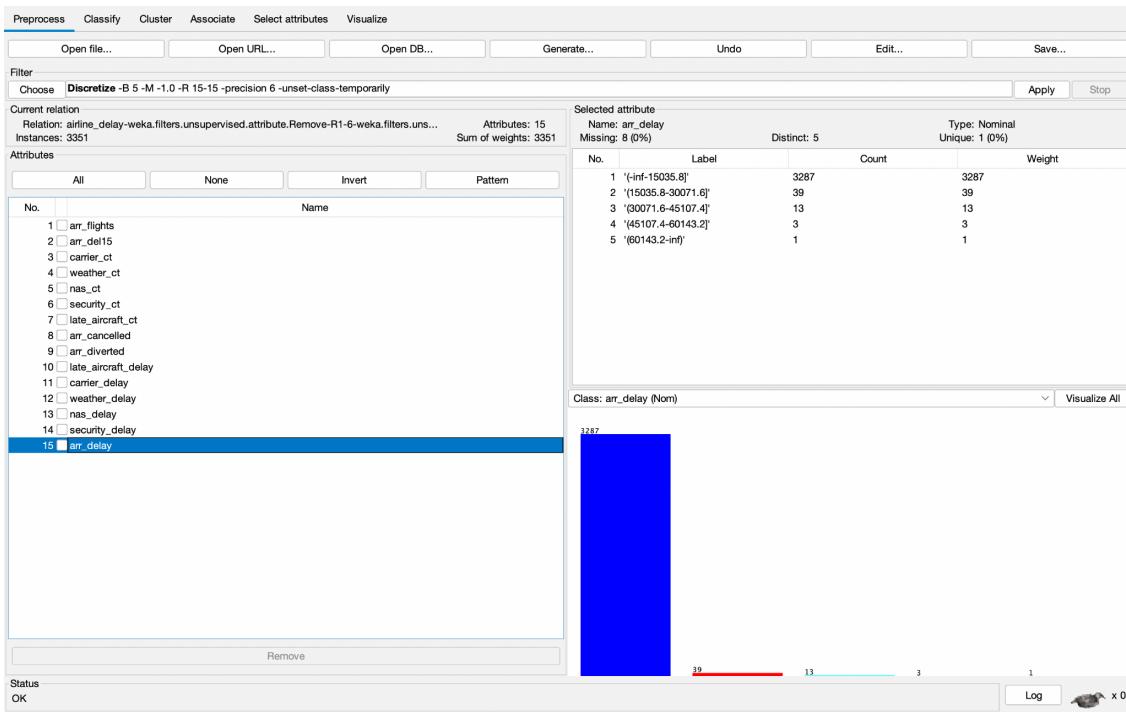
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2	-0.2418765...	-0.31493...	-0.361722...	-0.29930452...	-0.2861...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.321914604151334...	-0.330356013...	-0.241836926274...	-0.23462894...	-0.198842374124...	
3	-0.2441500...	-0.293913...	-0.247017...	-0.29930452...	-0.2584...	-0.21241186...	-0.29787105945...	-0.2848456878...	-0.202189447...	-0.2912872587060217...	-0.260918401...	-0.241836926274...	-0.22083804...	-0.198842374124...	
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Data after discretisation:

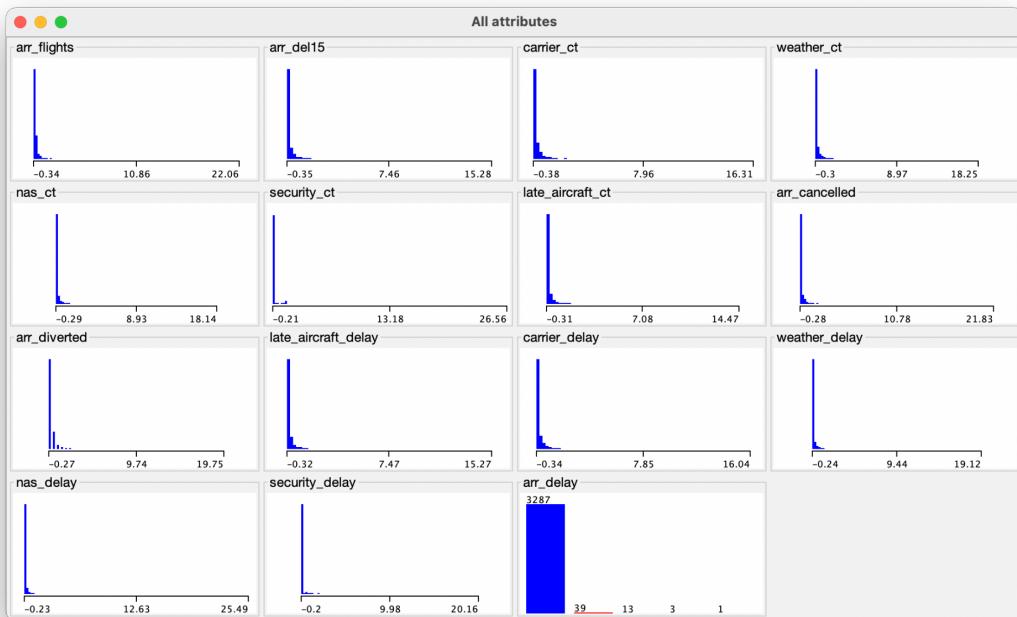


Relation: airline_delay-weka.filters.unsupervised.attribute.Remove-R1-6-weka.filters.unsupervised.attribute.StandardizeMissingValues-weka.filters.unsupervised.attribute.ReplaceMissingValues-weka.filters.unsupervised.attribute.Discretize-B5-M-1.0-R15-15...														
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7314...	-0.293513...	-0.241030...	-0.09190696...	-0.2839...	-0.21241186...	-0.294443633...	-0.2848456878...	-0.27448144...	-0.287592531380154...	-0.2491062893...	-0.21187191613...	-0.23242930...	-0.198842374124...	
6458...	-0.307167...	-0.326041...	-0.09182888...	-0.2410...	-0.21241186...	-0.30959395695...	-0.2848456878...	-0.27448144...	-0.30389968031258...	-0.3176296452...	-0.196898831063...	-0.21770174...	-0.198842374124...	
9155...	-0.054500...	-0.238875...	0.02345676...	0.13445...	-0.21241186...	-0.09641757474...	0.11015360...	-0.27448144...	-0.159929977418230...	-0.275507139...	-0.1056608860...	-0.02024110...	-0.198842374124...	
1500...	-0.252553...	-0.237199...	-0.29930452...	-0.1836...	-0.21241186...	-0.27316279857...	-0.0873471636...	-0.27448144...	-0.24977010654321...	-0.2532952321...	-0.15815012...	-0.198842374124...		
4504...	-0.307167...	-0.382555...	-0.29930452...	-0.2201...	-0.21241186...	-0.2708121907...	-0.2848456878...	-0.27448144...	-0.283314425992245...	-0.3308979204...	-0.241836926274...	-0.14216521...	-0.198842374124...	
1166...	-0.232073...	-0.267611...	-0.29930452...	-0.1531...	-0.21241186...	-0.22717296992...	-0.2848456878...	-0.27448144...	-0.24150568792247...	-0.2633449503...	-0.241836926274...	-0.16222470...	-0.198842374124...	
1239...	-0.341300...	-0.384710...	-0.29930452...	-0.2845...	-0.21241186...	-0.29303309593...	-0.160962957...	-0.27448144...	-0.32692441449591...	-0.3398811142...	-0.241836926274...	-0.23431351...	-0.198842374124...	
8337...	-0.293513...	-0.348790...	-0.29930452...	-0.1911...	-0.21241186...	-0.2897520734...	-0.2848456878...	-0.27448144...	-0.28008617283406...	-0.2998813196...	-0.241836926274...	-0.15344866...	-0.198842374124...	
4753...	-0.279800...	-0.277006...	-0.29930452...	-0.2756...	-0.21241186...	-0.2299621765...	-0.2848456878...	-0.27448144...	-0.2672012543...	-0.241836926274...	-0.22961207...	-0.198842374124...		
5007...	-0.273033...	-0.242467...	-0.29930452...	-0.2155...	-0.21241186...	-0.29083732095...	0.011020994...	-0.27448144...	-0.259007090154893...	-0.221518837...	-0.241836926274...	-0.16974701...	-0.198842374124...	
4590...	-0.156980...	-0.191940...	0.45354862...	-0.0993...	-0.21241186...	-0.20607175442...	0.4063991468...	-0.27448144...	-0.060878598386244...	-0.1719802091...	0.3340954846469...	-0.10706109...	-0.198842374124...	

Graphs after preprocessing:



Visualisation of various attributes after preprocessing:



Supervised learning:

i) Multi Layer Perceptron

```
== Stratified cross-validation ==
== Summary ==

Correctly Classified Instances      3319          99.2821 %
Incorrectly Classified Instances    24           0.7179 %
Kappa statistic                      0.7729
Mean absolute error                  0.0034
Root mean squared error              0.0478
Relative absolute error              24.4624 %
Root relative squared error         58.7937 %
Total Number of Instances            3343
Ignored Class Unknown Instances     8

== Detailed Accuracy By Class ==

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC   ROC Area  PRC Area  Class
0.999    0.143    0.998    0.999    0.998    0.897  0.947    0.998  '(-inf-15035.8]'
0.718    0.002    0.800    0.718    0.757    0.755  0.997    0.796  '(15035.8-30071.6]'
0.538    0.002    0.467    0.538    0.500    0.499  0.966    0.509  '(30071.6-45107.4)'
0.000    0.000    0.000    0.000    0.000    -0.001 0.999    0.371  '(45107.4-60143.2]'
0.000    0.000    ?        0.000    ?        ?      0.994    0.045  '(60143.2-inf)'
Weighted Avg.    0.993    0.140    ?        0.993    ?        ?      0.947    0.993

== Confusion Matrix ==

a   b   c   d   e  <-- classified as
3284 3   0   0   0 | a = '(-inf-15035.8]'
7   28  4   0   0 | b = '(15035.8-30071.6]'
1   4   7   1   0 | c = '(30071.6-45107.4)'
0   0   3   0   0 | d = '(45107.4-60143.2]'
0   0   1   0   0 | e = '(60143.2-inf)'
```

ii) Random Forest

```
== Stratified cross-validation ==
== Summary ==

Correctly Classified Instances      3317          99.2223 %
Incorrectly Classified Instances    26           0.7777 %
Kappa statistic                      0.7539
Mean absolute error                  0.0045
Root mean squared error              0.0472
Relative absolute error              32.4435 %
Root relative squared error         58.0261 %
Total Number of Instances            3343
Ignored Class Unknown Instances     8

== Detailed Accuracy By Class ==

      TP Rate  FP Rate  Precision  Recall  F-Measure  MCC   ROC Area  PRC Area  Class
0.999    0.161    0.997    0.999    0.998    0.878  0.935    0.998  '(-inf-15035.8]'
0.718    0.003    0.737    0.718    0.727    0.724  0.997    0.812  '(15035.8-30071.6]'
0.462    0.002    0.500    0.462    0.480    0.478  0.998    0.511  '(30071.6-45107.4)'
0.000    0.000    0.000    0.000    0.000    -0.001 0.995    0.094  '(45107.4-60143.2]'
0.000    0.000    ?        0.000    ?        ?      0.497    0.000  '(60143.2-inf)'
Weighted Avg.    0.992    0.158    ?        0.992    ?        ?      0.936    0.992

== Confusion Matrix ==

a   b   c   d   e  <-- classified as
3283 4   0   0   0 | a = '(-inf-15035.8]'
9   28  2   0   0 | b = '(15035.8-30071.6]'
0   6   6   1   0 | c = '(30071.6-45107.4)'
0   0   3   0   0 | d = '(45107.4-60143.2]'
0   0   1   0   0 | e = '(60143.2-inf)'
```

Unsupervised Learning:

i) Simple K-Means

```
Number of iterations: 24
Within cluster sum of squared errors: 70.570733990551

Initial starting points (random):

Cluster 0: 1.987276, 1.181045, 0.728568, 4.584908, 1.467604, -0.150538, 0.681081, 1.59139, 0.202189, 1.503572, 1.203237, 5.627351, 0.96957, -0.125208, '\'(-inf-15035
Cluster 1: -0.318038, -0.327647, -0.346875, -0.299305, -0.261655, -0.212412, -0.309594, -0.284846, -0.274481, -0.315595, -0.325639, -0.241837, -0.22209, -0.198842, ''
Cluster 2: -0.064545, -0.177461, -0.167994, 0.007644, -0.081941, -0.212412, -0.257111, -0.186096, -0.274481, -0.20592, -0.118289, -0.156046, -0.138717, -0.198842, '\
Cluster 3: -0.19527, -0.047754, -0.123214, -0.230863, -0.140428, -0.212412, 0.132269, 0.406399, -0.274481, 0.029571, -0.127484, -0.186005, -0.157837, -0.198842, '\

Missing values globally replaced with mean/mode

Final cluster centroids:

          Attribute      Full Data    Cluster#
                  (3351.0)      0       1       2       3
                                         (56.0)  (2930.0) (294.0) (71.0)
=====

arr_flights           0     4.8274   -0.2079   0.5346  2.5582
arr_del15            -0     5.9902   -0.2368   0.6297  2.4415
carrier_ct             0     5.1801   -0.2375   0.7489  2.6468
weather_ct              0     4.2117   -0.1805   0.3751  2.5756
nas_ct                 0     5.1329   -0.2071   0.5021  2.4172
security_ct             0     3.1619   -0.1538   0.4295  2.0754
late_aircraft_ct       -0     6.2976   -0.2186   0.557  1.7488
arr_cancelled          -0     4.3229   -0.1836   0.4319  2.3772
arr_diverted            0     3.5474   -0.1605   0.4892  1.8
late_aircraft_delay     -0     6.0169   -0.2265   0.5397  2.3669
carrier_delay           -0     5.4014   -0.2233   0.5907  2.5071
weather_delay            0     3.6316   -0.1527   0.2846  2.258
nas_delay                0     4.4611   -0.1776   0.381  2.2327
security_delay           -0     2.7478   -0.1472   0.4192  2.1709
arr_delay               '( -inf-15035.8)' '(15035.8-30071.6)' '( -inf-15035.8)' '( -inf-15035.8)' '( -inf-15035.8)'

Time taken to build model (full training data) : 0.08 seconds
== Model and evaluation on training set ==
Clustered Instances
0      56 ( 2%)
1      2930 ( 87%)
2      294 ( 9%)
3       71 ( 2%)
```

Report:

Multi-layered perceptron performs better than random forest. Random forest is not considerate of all the attributes to build the entire collection of trees to classify under the discretized labels, as it has a high chance of missing a few attributes when evaluating greedily for the attribute yield the best split. Whereas, the multi-layered perceptron considers all the attributes to build the entire perceptron work, which is then later utilised to learn through back propagation.