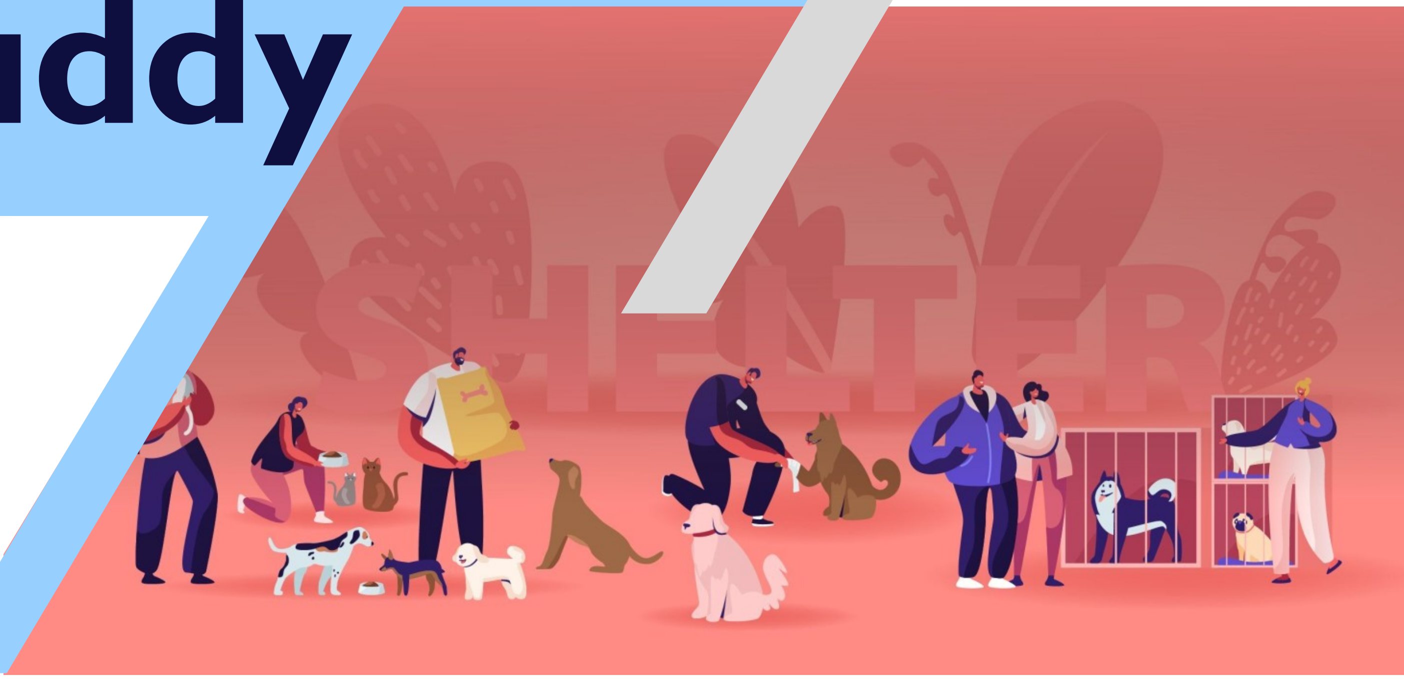
Documentation of
Machine Learning Project

Machine Learning challenge

-By Pritimoy Sarkar

Adopt a Buddy



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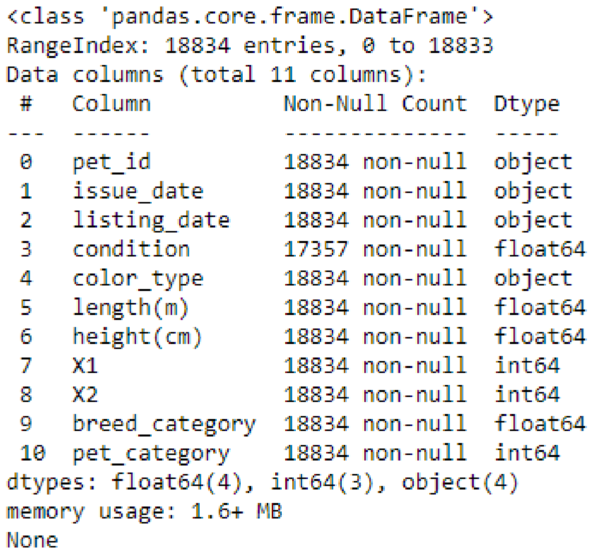
Contents

About the Dataset

Features

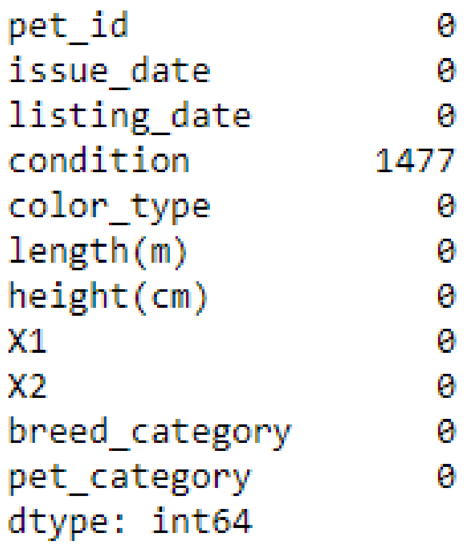
The dataset provided by Hackerearth had 18834 instances and 11 columns. Among those 11 columns 9 column was supposed to be input feature and 2 columns was supposed to be label

- Input Features:
    1) Pet_id
    2) Issue_date
    3) Listing_date
    4) Condition
    5) Color_type
    6) Length(m)
    7) Height (cm)
    8) X1
    9) X2
- Output Feature (label):
    1) Breed_category
    2) Pet_category



```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18834 entries, 0 to 18833
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   pet_id          18834 non-null  object
 1   issue_date      18834 non-null  object
 2   listing_date    18834 non-null  object
 3   condition       17357 non-null  float64
 4   color_type      18834 non-null  object
 5   length(m)       18834 non-null  float64
 6   height(cm)      18834 non-null  float64
 7   X1              18834 non-null  int64
 8   X2              18834 non-null  int64
 9   breed_category  18834 non-null  float64
 10  pet_category    18834 non-null  int64
dtypes: float64(4), int64(3), object(4)
memory usage: 1.6+ MB
None
```

18834 instances with 11 Colum (9 features 2 label)



```
pet_id               0
issue_date           0
listing_date         0
condition         1477
color_type           0
length(m)            0
height(cm)           0
X1                   0
X2                   0
breed_category       0
pet_category         0
dtype: int64
```

1477 NaN value in ‘condition’ feature

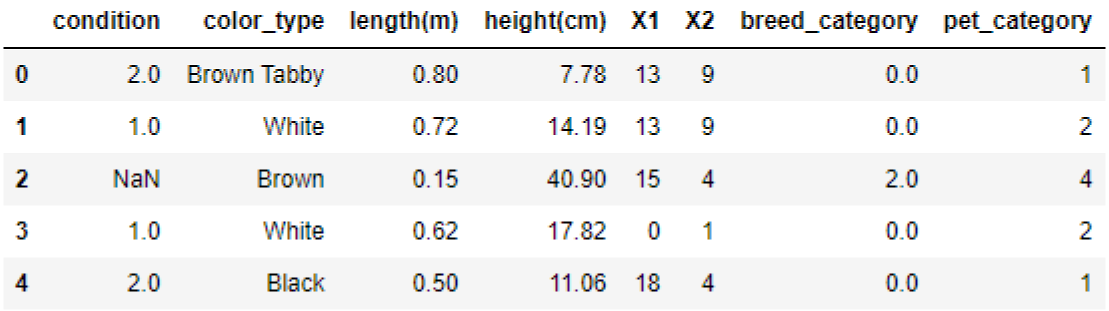
Data pre-processing

Redundant feature removal

Redundant features like

1) Pet_id
2) Issue_date
3) Listing_date

Was removes, as these features were irrelevant to predict the output in our case



	condition	color_type	length(m)	height(cm)	X1	X2	breed_category	pet_category
0	2.0	Brown Tabby	0.80	7.78	13	9	0.0	1
1	1.0	White	0.72	14.19	13	9	0.0	2
2	NaN	Brown	0.15	40.90	15	4	2.0	4
3	1.0	White	0.62	17.82	0	1	0.0	2
4	2.0	Black	0.50	11.06	18	4	0.0	1

The dataset, after removing redundant features

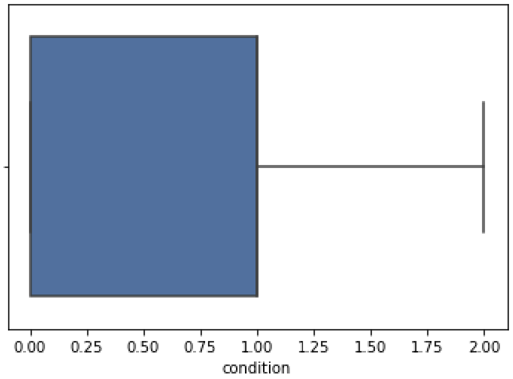
From Now on, further work will be done on these 6 input feature and 2 output feature (label) would

Univariate Analysis

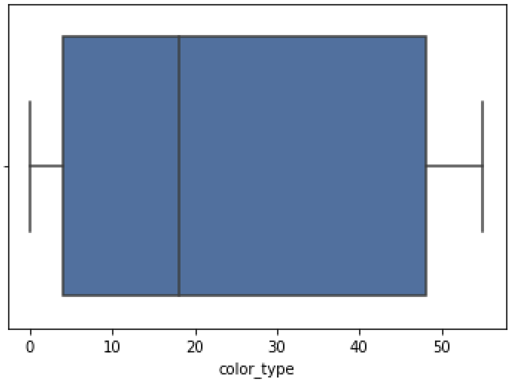
After Numeric Encoding of classification features NaN value treatment and skewness and outliers checking and removal was done

Below we will check some box plot to visualize any existence of outliers:

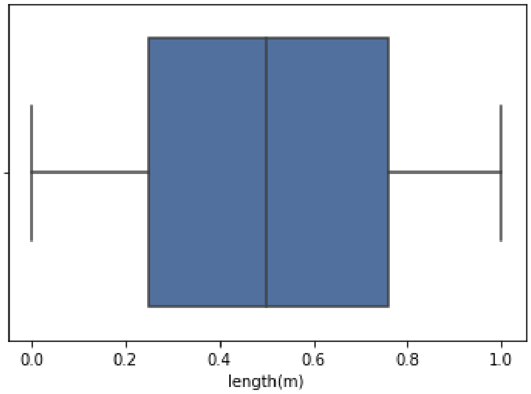
Data pre-processing



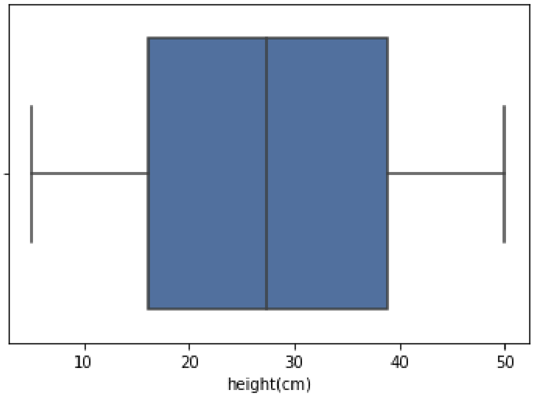
Boxplot of ‘Condition’ colum



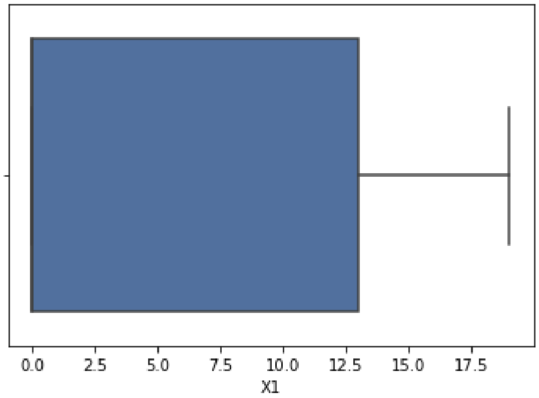
Boxplot of ‘color_type’ colum



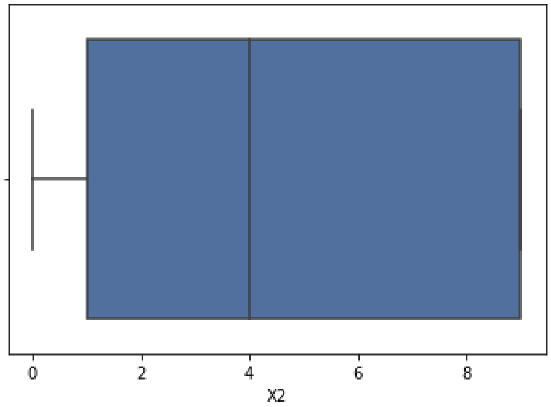
Boxplot of ‘length(m)’ colum



Boxplot of ‘height(cm)’ colum



Boxplot of ‘x1’ colum

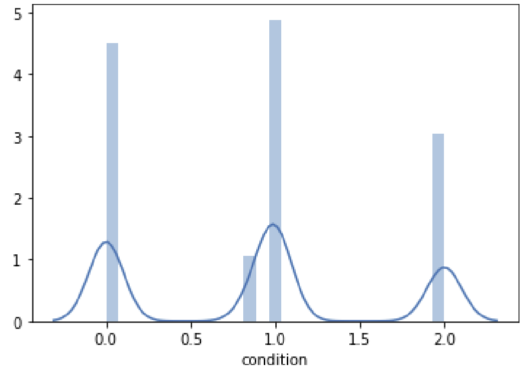


Boxplot of ‘x2’ colum

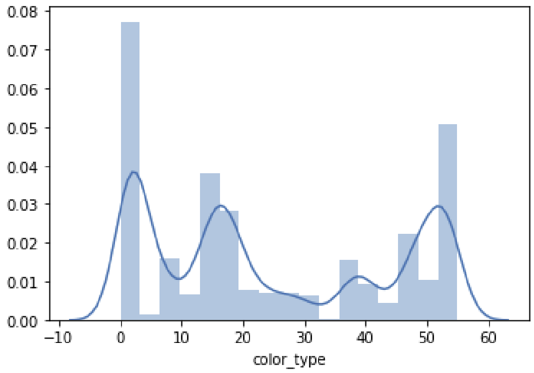
Data pre-processing

As we can see there is no outliers in any of the 6 features, we will move forward to check skewness of the input features

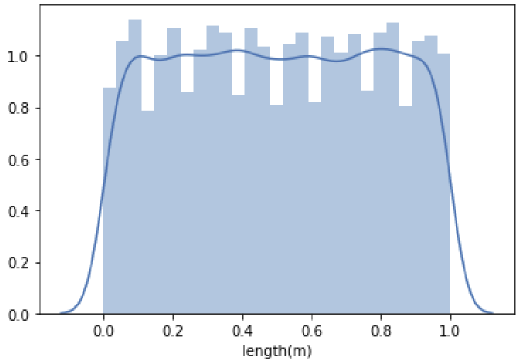
Below we will check some distribution plot to visualize any existence of outliers:



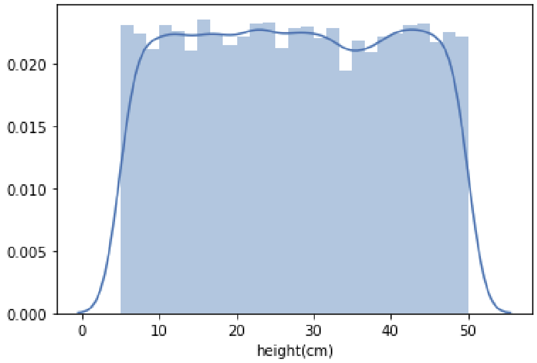
Distribution plot of 'Condition' colum



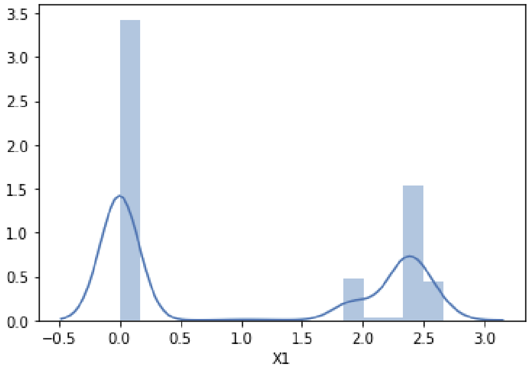
Distribution plot of 'Condition' colum



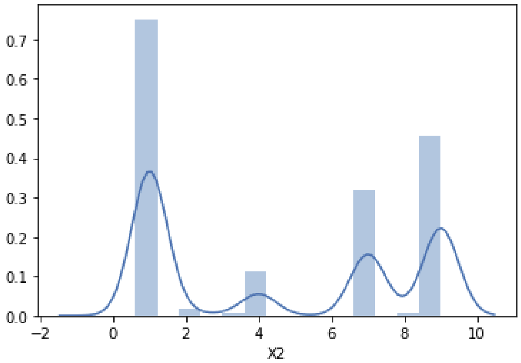
Distribution plot of 'Condition' colum



Distribution plot of 'Condition' colum



Distribution plot of 'Condition' colum

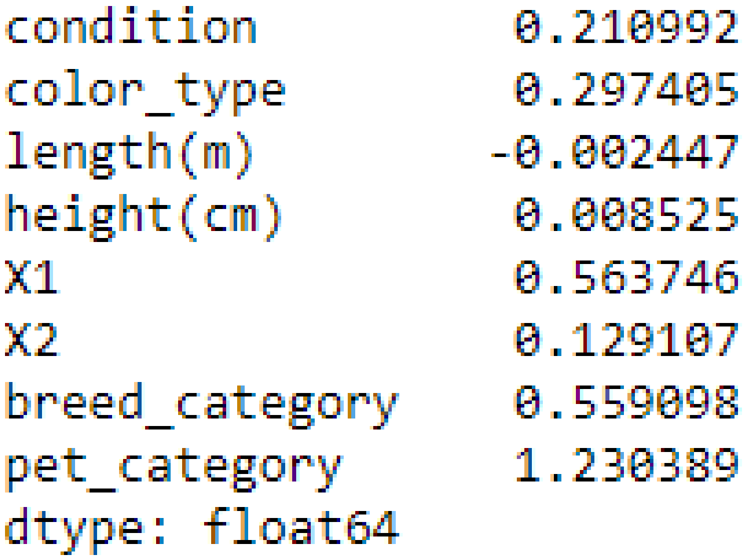


Distribution plot of 'Condition' colum

Data pre-processing

From these distribution plot its hard to visualize minor skewness as the data seems more or less equally distributed.

For fine tuning the skewness is checked manually by the skew values



```
condition           0.210992
color_type          0.297405
length(m)          -0.002447
height(cm)          0.008525
X1                  0.563746
X2                  0.129107
breed_category      0.559098
pet_category        1.230389
dtype: float64
```

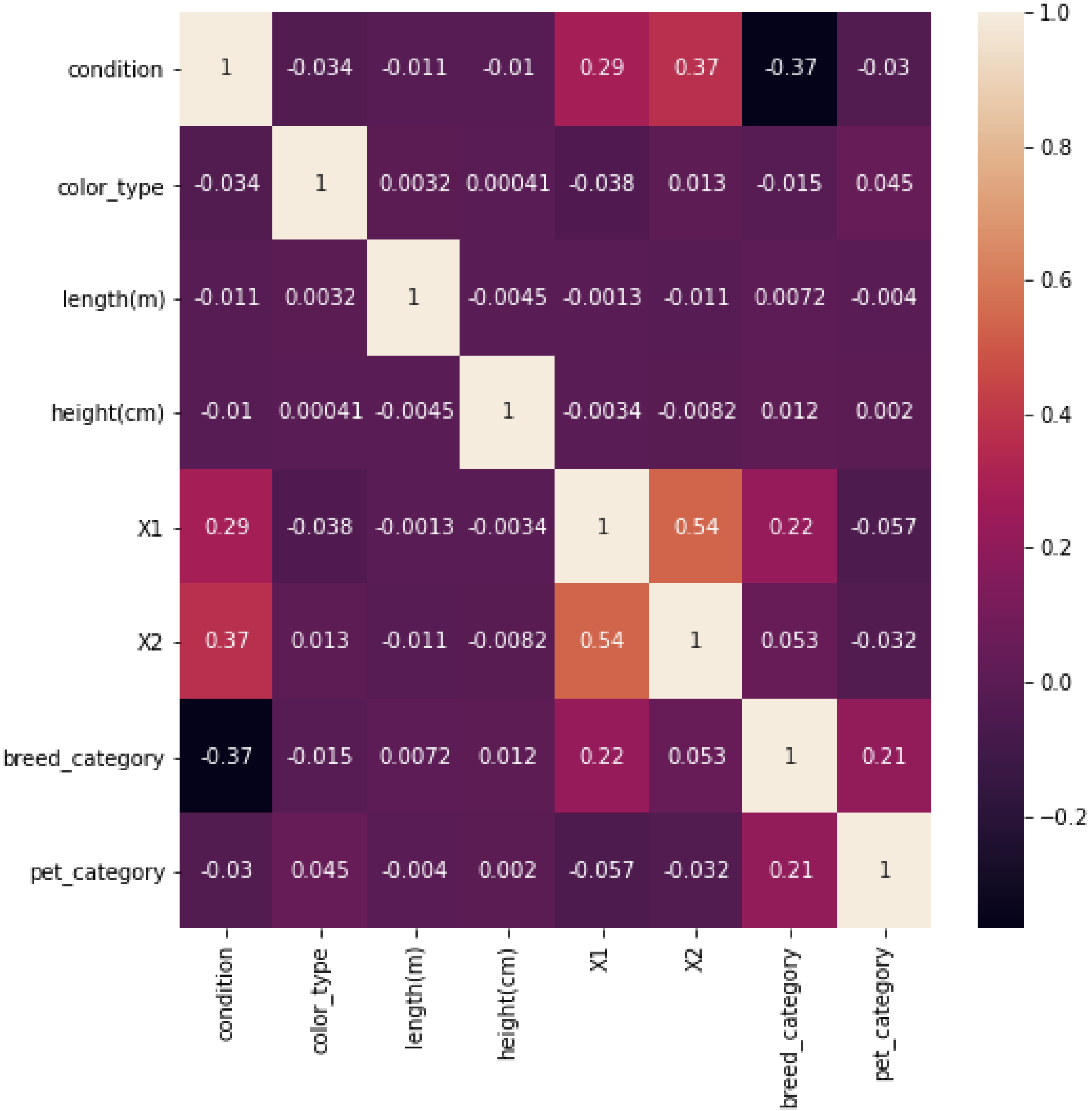
Skew value of all features of the dataset

As our dataset doesn’t contains highly skewed input feature, tampering the input data is avoided here

Data pre-processing

Bivariate Analysis

Visualize the relation between the features



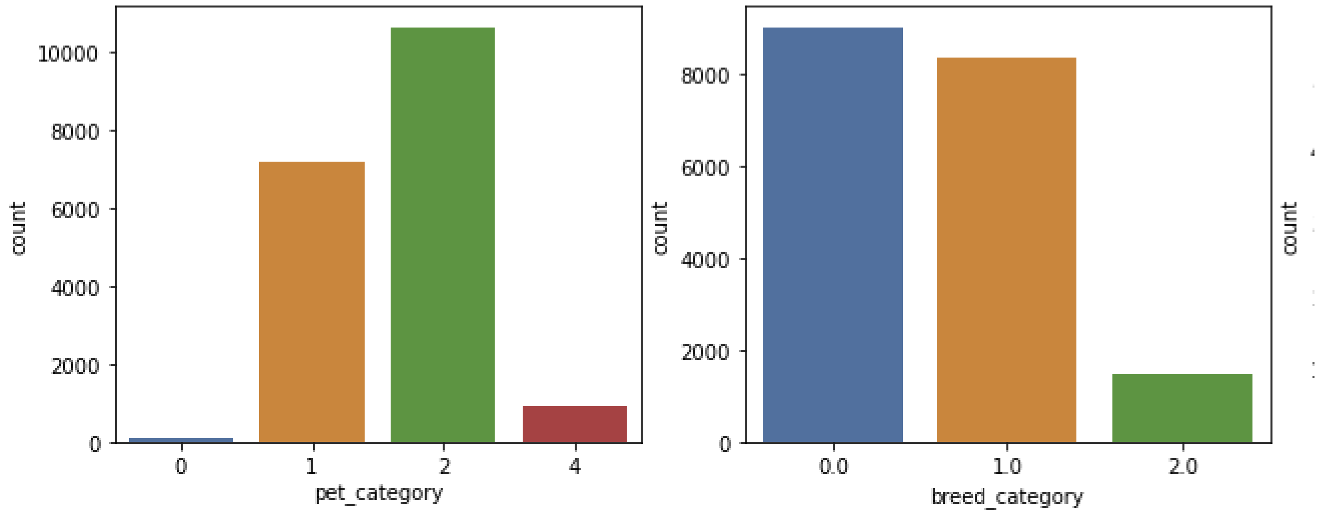
	condition	color_type	length(m)	height(cm)	X1	X2	breed_category	pet_category
condition	1	-0.034	-0.011	-0.01	0.29	0.37	-0.37	-0.03
color_type	-0.034	1	0.0032	0.00041	-0.038	0.013	-0.015	0.045
length(m)	-0.011	0.0032	1	-0.0045	-0.0013	-0.011	0.0072	-0.004
height(cm)	-0.01	0.00041	-0.0045	1	-0.0034	-0.0082	0.012	0.002
X1	0.29	-0.038	-0.0013	-0.0034	1	0.54	0.22	-0.057
X2	0.37	0.013	-0.011	-0.0082	0.54	1	0.053	-0.032
breed_category	-0.37	-0.015	0.0072	0.012	0.22	0.053	1	0.21
pet_category	-0.03	0.045	-0.004	0.002	-0.057	-0.032	0.21	1

Having a smaller number of input features, reduction of curse of dimensionality is avoided

Data pre-processing

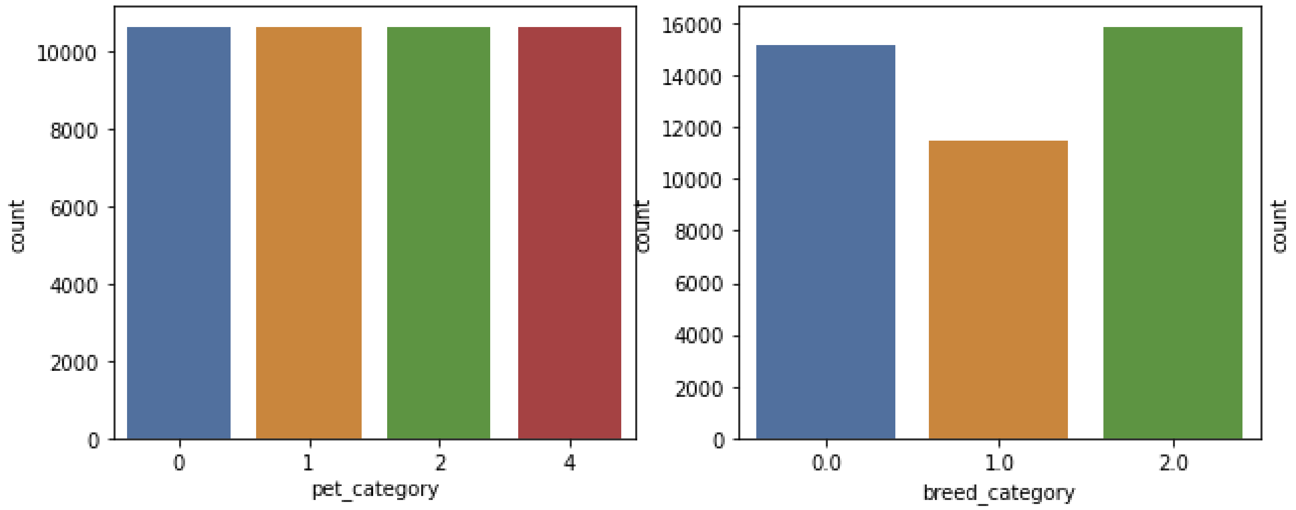
Class Imbalance

Count-plot is used to visualize the class imbalance in the two output columns (label)



- ➢ **Using upsampling the class imbalance in the output columns is removed**

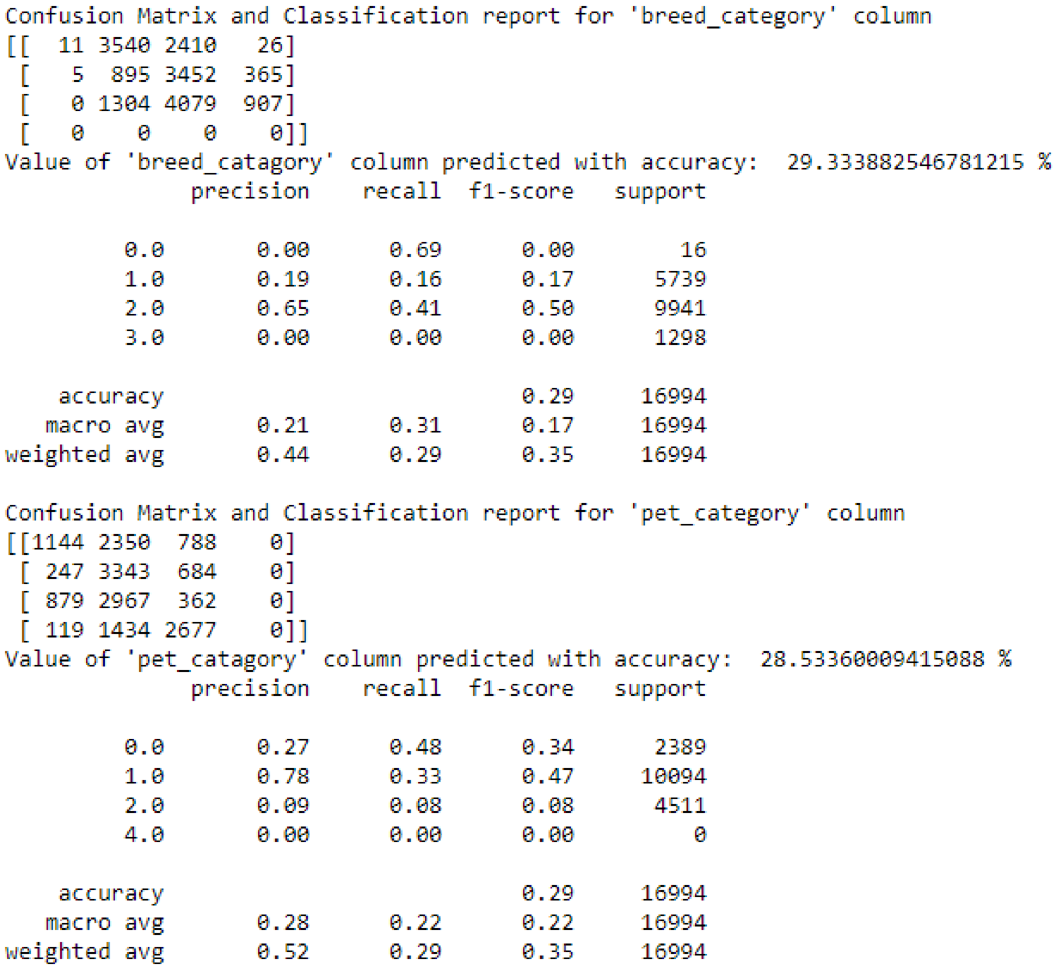
Count plot is reused to visualize the effect of resampling to remove class imbalance and the class imbalance is gone from ‘pet_catagory’ and in breed category the class imbalance is reduced significantly



Multioutput Regression Method

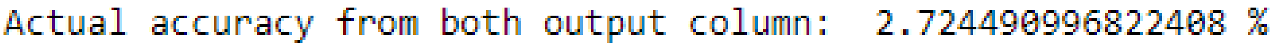
- **Some models which are able to make multioutput prediction are used here and there performance report is shown here**

Logistic Regression Model



```
Confusion Matrix and Classification report for 'breed_category' column
[[  11 3540 2410   26]
 [   5  895 3452  365]
 [   0 1304 4079  907]
 [   0    0    0    0]]
Value of 'breed_catagory' column predicted with accuracy:  29.333882546781215 %
              precision    recall  f1-score   support

         0.0       0.00      0.69      0.00        16
         1.0       0.19      0.16      0.17      5739
         2.0       0.65      0.41      0.50      9941
         3.0       0.00      0.00      0.00      1298

    accuracy                           0.29     16994
   macro avg       0.21      0.31      0.17     16994
weighted avg       0.44      0.29      0.35     16994

Confusion Matrix and Classification report for 'pet_category' column
[[1144 2350  788    0]
 [ 247 3343  684    0]
 [ 879 2967  362    0]
 [ 119 1434 2677    0]]
Value of 'pet_catagory' column predicted with accuracy:  28.53360009415088 %
              precision    recall  f1-score   support

         0.0       0.27      0.48      0.34      2389
         1.0       0.78      0.33      0.47     10094
         2.0       0.09      0.08      0.08      4511
         4.0       0.00      0.00      0.00         0

    accuracy                           0.29     16994
   macro avg       0.28      0.22      0.22     16994
weighted avg       0.52      0.29      0.35     16994
```

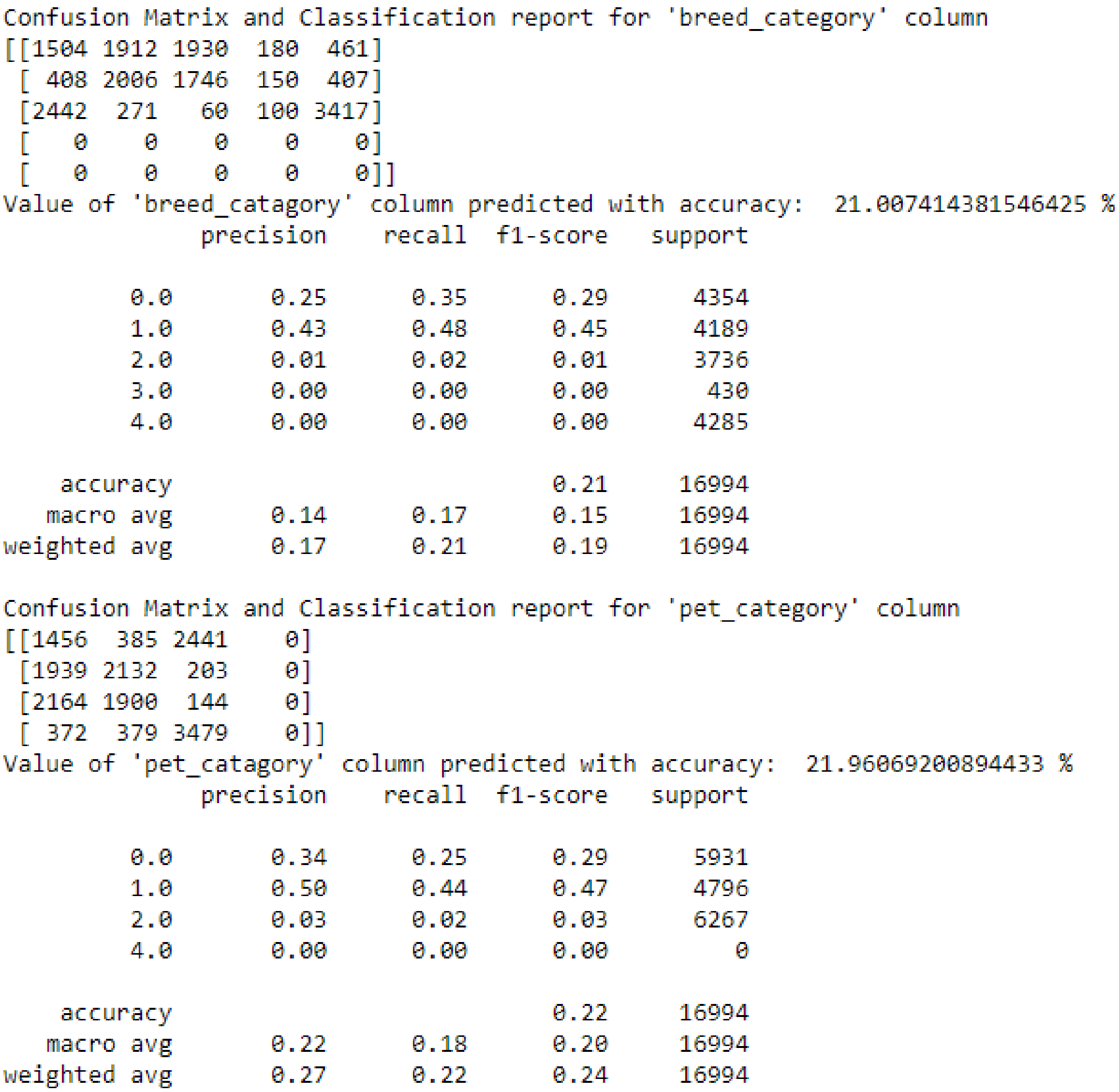
Performance result of Logistic Regressor Model



```
Actual accuracy from both output column:  2.72449096822408 %
```

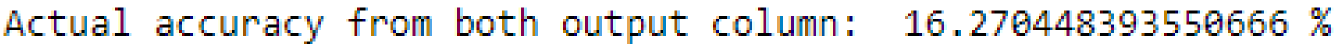
Actual accuracy is when both of the outputs are predicted correctly at once

K Nearest Neighbors Model



```
Confusion Matrix and Classification report for 'breed_category' column
[[1504 1912 1930  180  461]
 [ 408 2006 1746  150  407]
 [2442  271   60  100 3417]
 [   0    0    0    0    0]
 [   0    0    0    0    0]]
Value of 'breed_catagory' column predicted with accuracy:  21.007414381546425 %
              precision    recall  f1-score   support

         0.0       0.25      0.35      0.29      4354
         1.0       0.43      0.48      0.45      4189
         2.0       0.01      0.02      0.01      3736
         3.0       0.00      0.00      0.00       430
         4.0       0.00      0.00      0.00      4285

    accuracy                           0.21     16994
   macro avg       0.14      0.17      0.15     16994
weighted avg       0.17      0.21      0.19     16994

Confusion Matrix and Classification report for 'pet_category' column
[[1456  385 2441    0]
 [1939 2132  203    0]
 [2164 1900  144    0]
 [ 372  379 3479    0]]
Value of 'pet_catagory' column predicted with accuracy:  21.96069200894433 %
              precision    recall  f1-score   support

         0.0       0.34      0.25      0.29      5931
         1.0       0.50      0.44      0.47      4796
         2.0       0.03      0.02      0.03      6267
         4.0       0.00      0.00      0.00         0

    accuracy                           0.22     16994
   macro avg       0.22      0.18      0.20     16994
weighted avg       0.27      0.22      0.24     16994
```

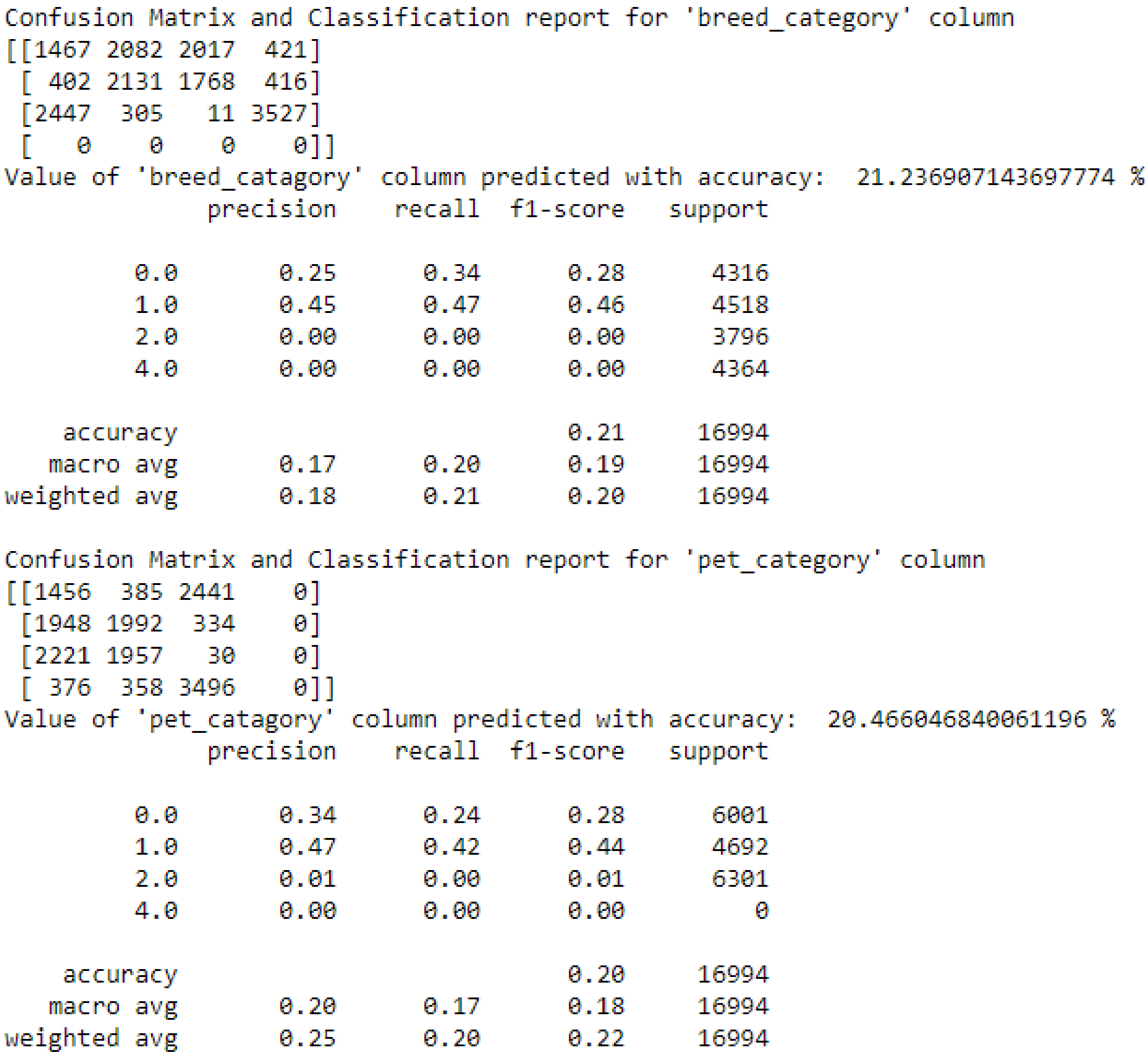
Performance result of K Neighbors Regressor Model



```
Actual accuracy from both output column:  16.270448393550666 %
```

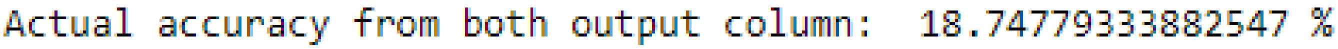
Accuracy result of K Neighbors Regressor Model

Decision Tree Regressor Model



```
Confusion Matrix and Classification report for 'breed_category' column
[[1467 2082 2017  421]
 [ 402 2131 1768  416]
 [2447  305   11 3527]
 [   0    0    0    0]]
Value of 'breed_catagory' column predicted with accuracy:  21.236907143697774 %
              precision    recall  f1-score   support

         0.0       0.25      0.34      0.28      4316
         1.0       0.45      0.47      0.46      4518
         2.0       0.00      0.00      0.00      3796
         4.0       0.00      0.00      0.00      4364

    accuracy                           0.21     16994
   macro avg       0.17      0.20      0.19     16994
weighted avg       0.18      0.21      0.20     16994

Confusion Matrix and Classification report for 'pet_category' column
[[1456  385 2441    0]
 [1948 1992  334    0]
 [2221 1957   30    0]
 [ 376  358 3496    0]]
Value of 'pet_catagory' column predicted with accuracy:  20.466046840061196 %
              precision    recall  f1-score   support

         0.0       0.34      0.24      0.28      6001
         1.0       0.47      0.42      0.44      4692
         2.0       0.01      0.00      0.01      6301
         4.0       0.00      0.00      0.00         0

    accuracy                           0.20     16994
   macro avg       0.20      0.17      0.18     16994
weighted avg       0.25      0.20      0.22     16994
```

Performance result of Decision Tree Regressor Model



```
Actual accuracy from both output column:  18.74779333882547 %
```

Accuracy result of Decision Tree Regressor Model

As we can see the Decision Tree Classifier is giving us best accuracy but this value is not up to the mark so another process is followed to get multioutput prediction

Model Building

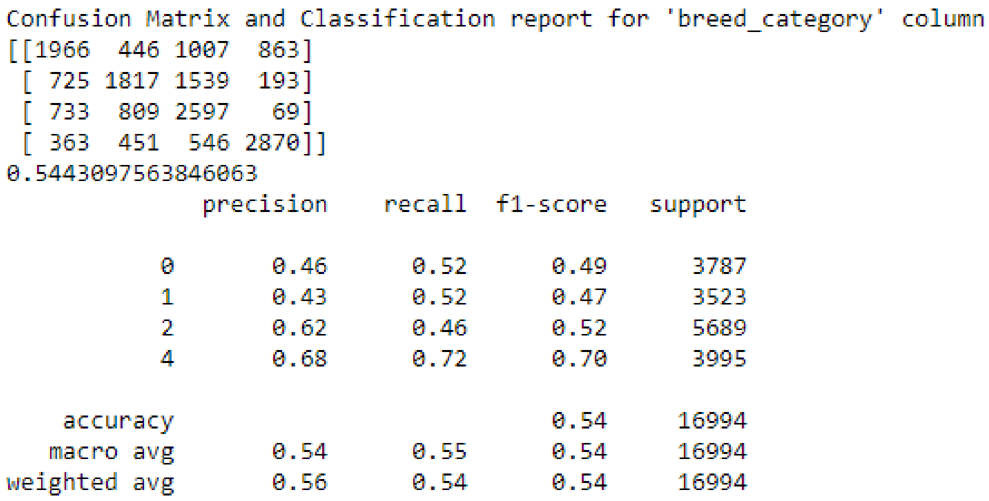
Chained Multioutput Regression Method

In this method only one output feature is predicted at once.

After predicting one output column, all previous taken columns and this predicted output column is taken as input features to predict another output feature

To determine the best algorithm for predicting the output one column is chosen and some relevant model are created to determine the best algorithm by observing their performance in this dataset

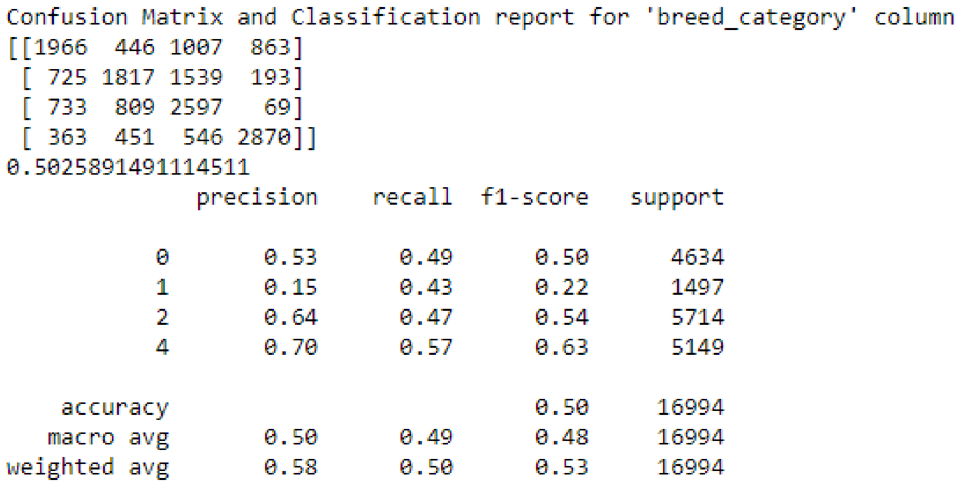
Gaussian Naive Bayes



```
Confusion Matrix and Classification report for 'breed_category' column
[[1966  446 1007  863]
 [ 725 1817 1539  193]
 [ 733  809 2597   69]
 [ 363  451  546 2870]]
0.5443097563846063
              precision    recall  f1-score   support

           0       0.46      0.52      0.49      3787
           1       0.43      0.52      0.47      3523
           2       0.62      0.46      0.52      5689
           4       0.68      0.72      0.70      3995

    accuracy                           0.54     16994
   macro avg       0.54      0.55      0.54     16994
weighted avg       0.56      0.54      0.54     16994
```

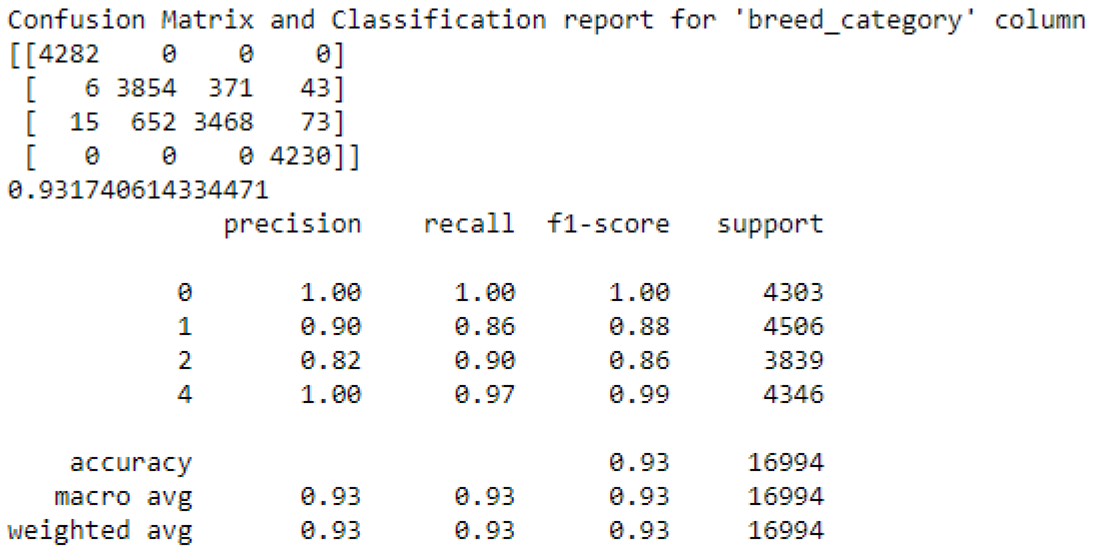
Model Building

Linear Support Vector Machine



```
Confusion Matrix and Classification report for 'breed_category' column
[[1966  446 1007  863]
 [ 725 1817 1539  193]
 [ 733  809 2597   69]
 [ 363  451  546 2870]]
0.5025891491114511
              precision    recall  f1-score   support

           0       0.53      0.49      0.50      4634
           1       0.15      0.43      0.22      1497
           2       0.64      0.47      0.54      5714
           4       0.70      0.57      0.63      5149

    accuracy                           0.50     16994
   macro avg       0.50      0.49      0.48     16994
weighted avg       0.58      0.50      0.53     16994
```

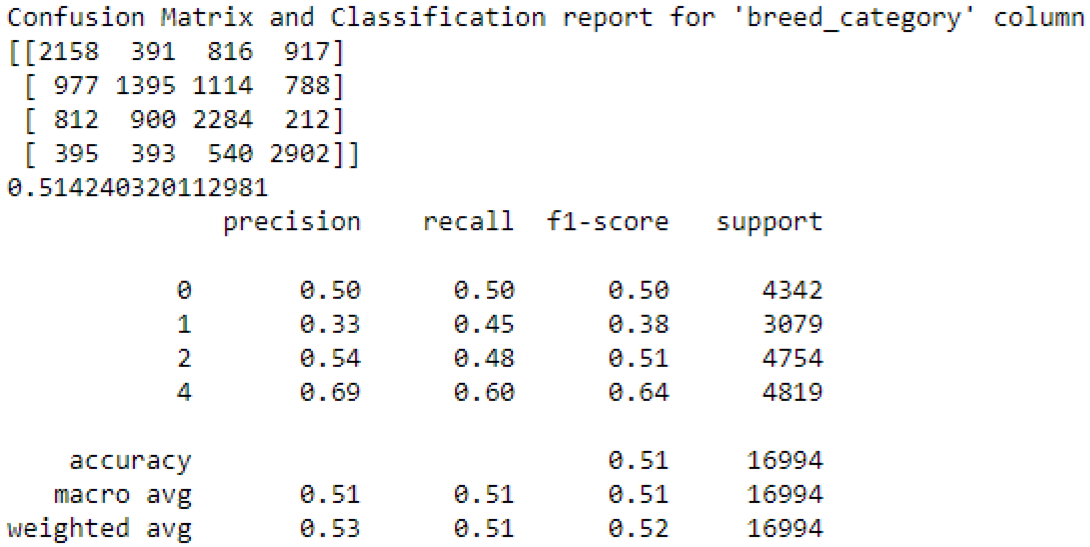
Decision Tree Classifier



```
Confusion Matrix and Classification report for 'breed_category' column
[[4282    0    0    0]
 [   6 3854  371   43]
 [  15  652 3468   73]
 [   0    0    0 4230]]
0.931740614334471
              precision    recall  f1-score   support

           0       1.00      1.00      1.00      4303
           1       0.90      0.86      0.88      4506
           2       0.82      0.90      0.86      3839
           4       1.00      0.97      0.99      4346

    accuracy                           0.93     16994
   macro avg       0.93      0.93      0.93     16994
weighted avg       0.93      0.93      0.93     16994
```

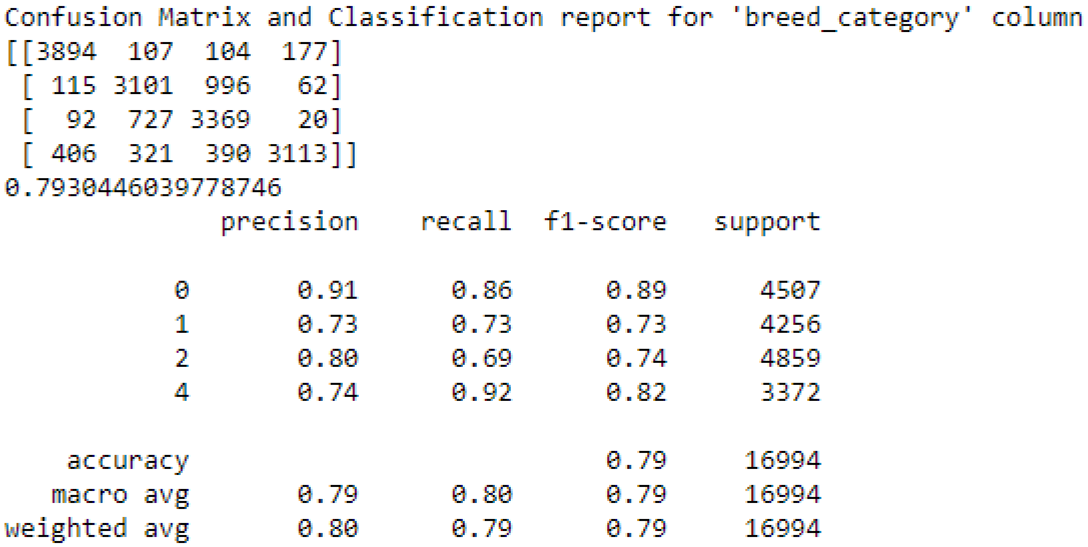
Model Building

Logistic Regression



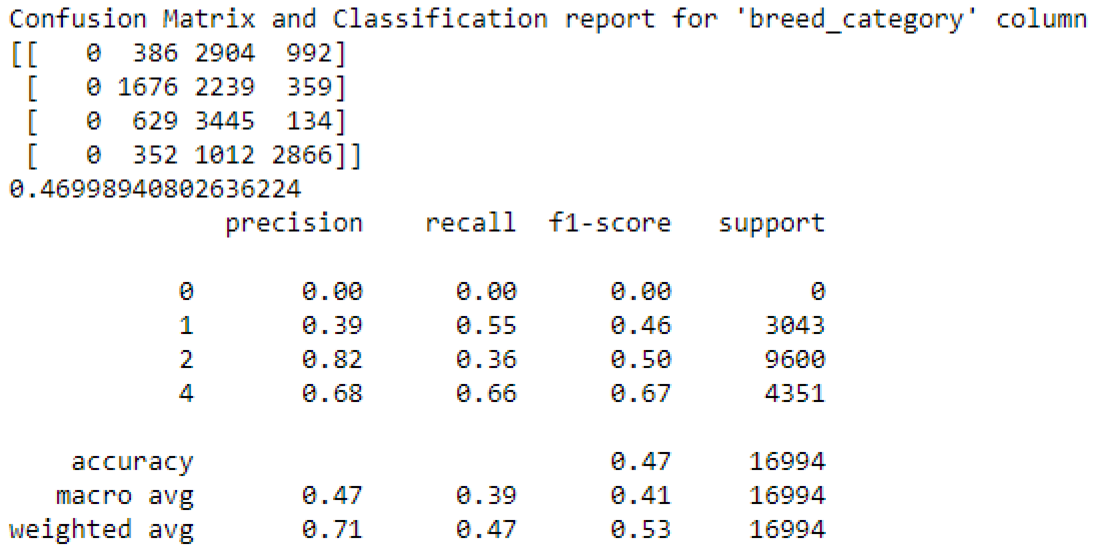
```
Confusion Matrix and Classification report for 'breed_category' column
[[2158  391  816  917]
 [ 977 1395 1114  788]
 [ 812  900 2284  212]
 [ 395  393  540 2902]]
0.514240320112981
              precision    recall  f1-score   support

           0       0.50      0.50      0.50      4342
           1       0.33      0.45      0.38      3079
           2       0.54      0.48      0.51      4754
           4       0.69      0.60      0.64      4819

    accuracy                           0.51     16994
   macro avg       0.51      0.51      0.51     16994
weighted avg       0.53      0.51      0.52     16994
```

Random Forest Classifier



```
Confusion Matrix and Classification report for 'breed_category' column
[[3894  107  104  177]
 [ 115 3101  996   62]
 [  92  727 3369   20]
 [ 406  321  390 3113]]
0.7930446039778746
              precision    recall  f1-score   support

           0       0.91      0.86      0.89      4507
           1       0.73      0.73      0.73      4256
           2       0.80      0.69      0.74      4859
           4       0.74      0.92      0.82      3372

    accuracy                           0.79     16994
   macro avg       0.79      0.80      0.79     16994
weighted avg       0.80      0.79      0.79     16994
```

Multi-Layer Perception Classifier



```
Confusion Matrix and Classification report for 'breed_category' column
[[   0  386 2904  992]
 [   0 1676 2239  359]
 [   0  629 3445  134]
 [   0  352 1012 2866]]
0.46998940802636224
              precision    recall  f1-score   support

           0       0.00      0.00      0.00         0
           1       0.39      0.55      0.46      3043
           2       0.82      0.36      0.50      9600
           4       0.68      0.66      0.67      4351

    accuracy                           0.47     16994
   macro avg       0.47      0.39      0.41     16994
weighted avg       0.71      0.47      0.53     16994
```

From these reports above its clear that Decision Tree Classifier perform the best in our dataset. To visualize the model's accuracy in one place a chart is given below

Chart 1:

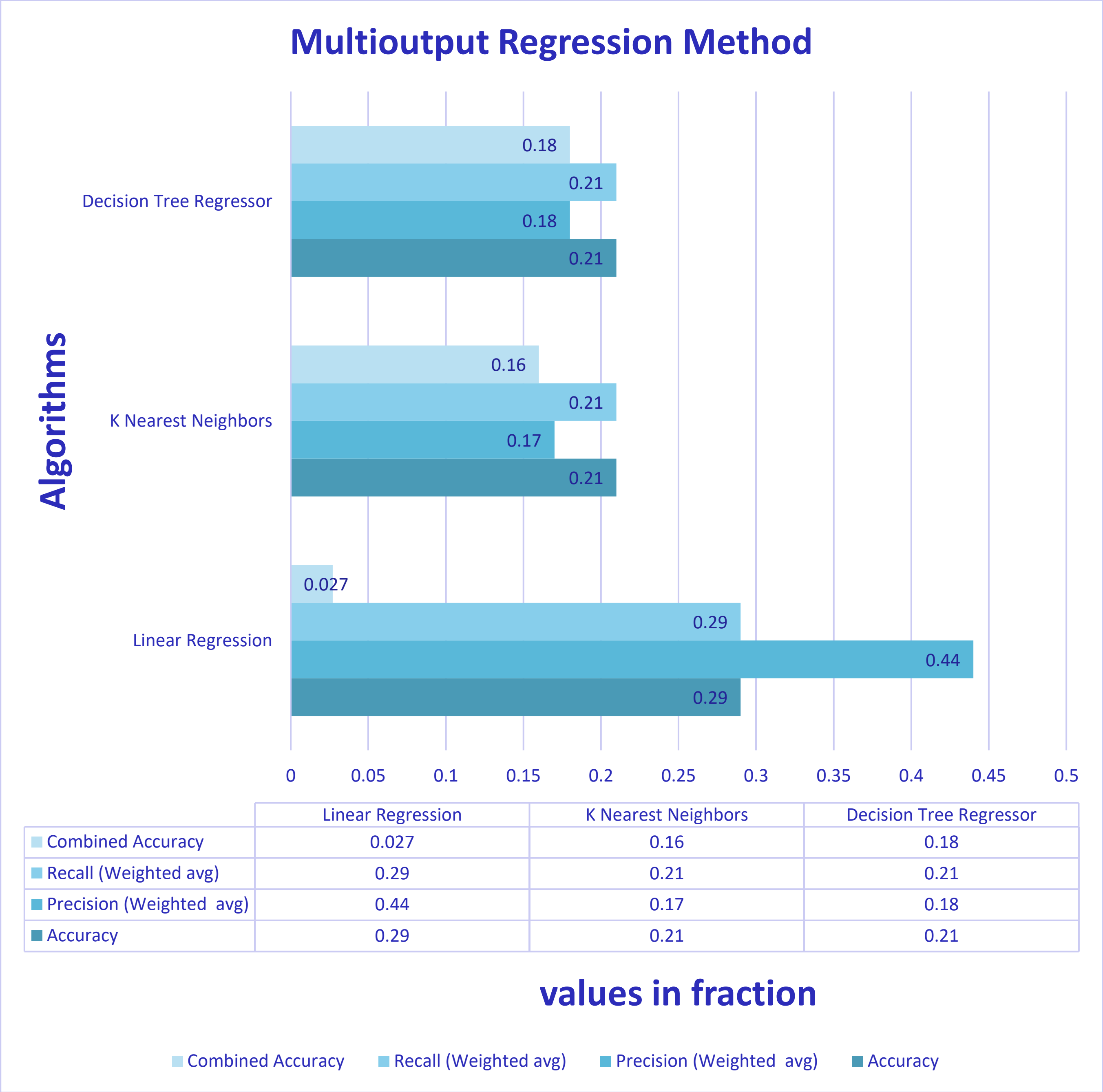
Accuracy, precision and recall of all model used in **Multioutput Regressor Method** is plotted in this chart

Chart 2:

Accuracy, precision and recall of all model used in **Chained Multioutput Regression Method** is plotted in this chart

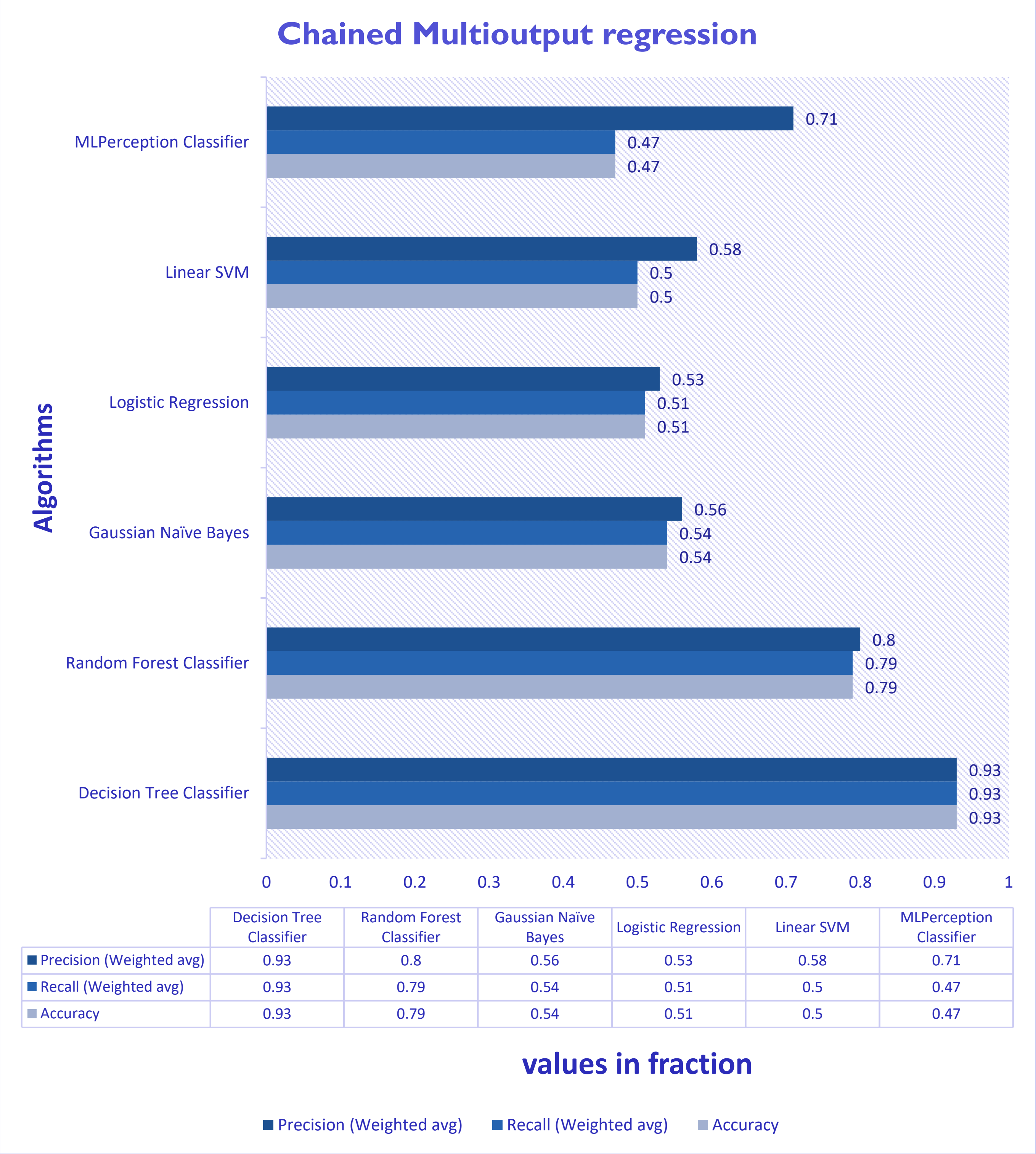
Performance Analyzing

Chart I



	Linear Regression	K Nearest Neighbors	Decision Tree Regressor
Combined Accuracy	0.027	0.16	0.18
Recall (Weighted avg)	0.29	0.21	0.21
Precision (Weighted avg)	0.44	0.17	0.18
Accuracy	0.29	0.21	0.21

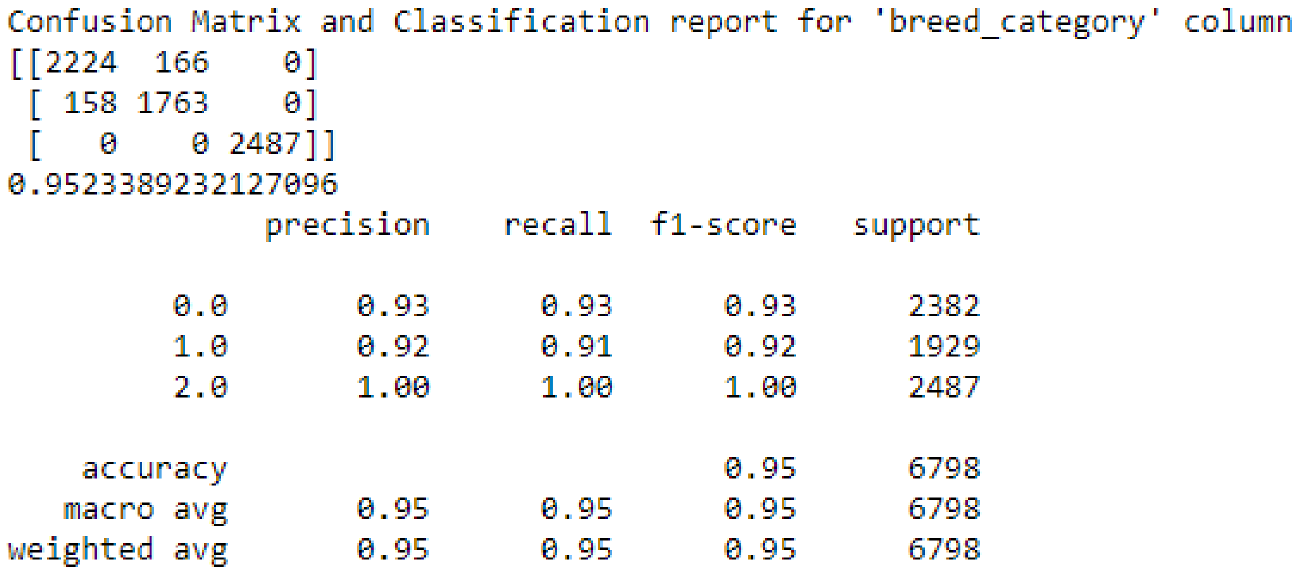
Chart 2



	Decision Tree Classifier	Random Forest Classifier	Gaussian Naïve Bayes	Logistic Regression	Linear SVM	MLPerception Classifier
■ Precision (Weighted avg)	0.93	0.8	0.56	0.53	0.58	0.71
■ Recall (Weighted avg)	0.93	0.79	0.54	0.51	0.5	0.47
■ Accuracy	0.93	0.79	0.54	0.51	0.5	0.47

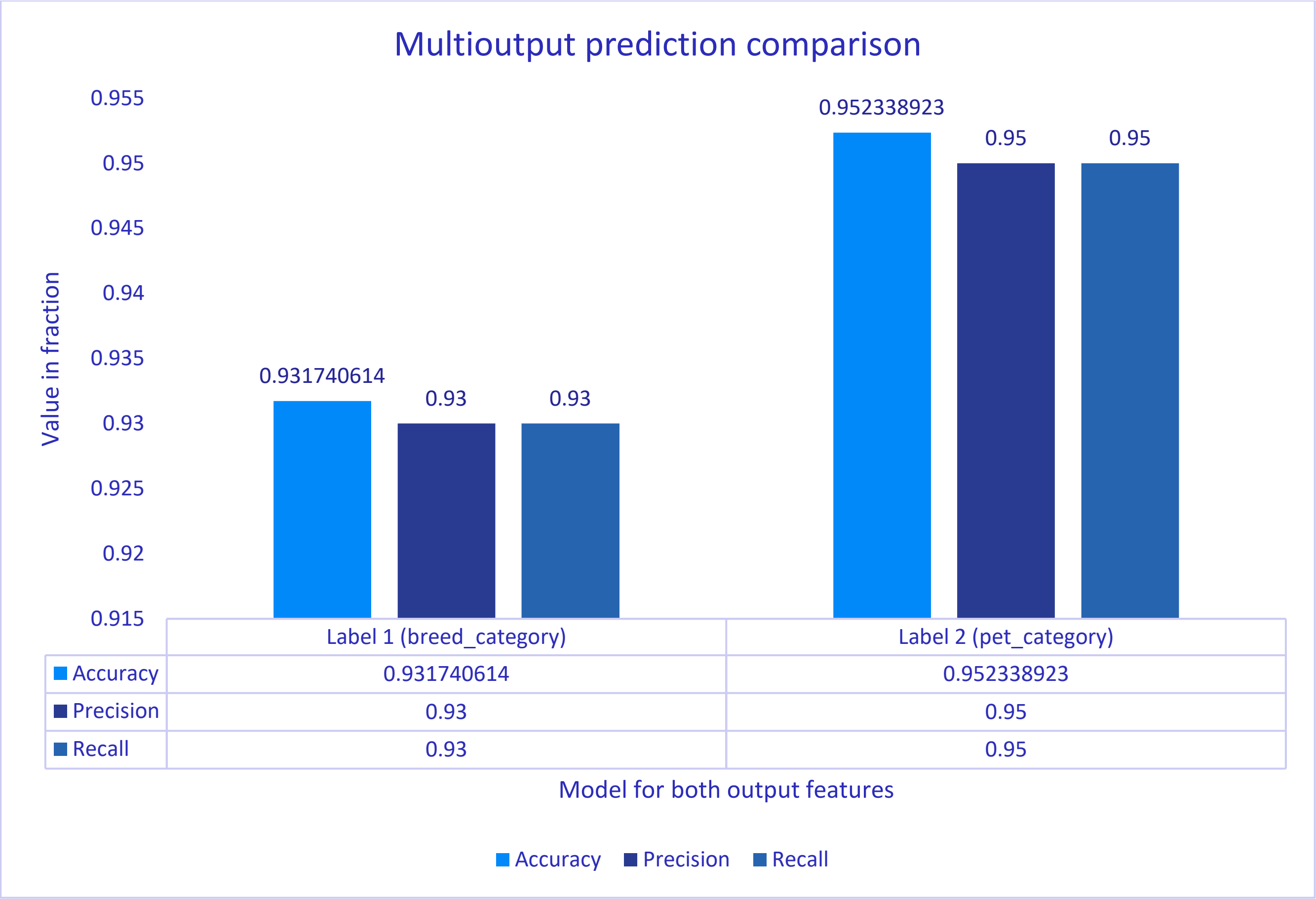
From these charts above it’s clear that **Decision Tree Classifier** model gives the best output in our case so, **Decision Tree Classifier** is used as the final model to predict this feature as well as to predict the next output feature.

Decision Tree Classifier (Performance report label 2 output)



```
Confusion Matrix and Classification report for 'breed_category' column
[[2224  166    0]
 [ 158 1763    0]
 [   0    0 2487]]
0.9523389232127096
              precision    recall  f1-score   support

         0.0       0.93      0.93      0.93      2382
         1.0       0.92      0.91      0.92      1929
         2.0       1.00      1.00      1.00      2487

    accuracy                           0.95      6798
   macro avg       0.95      0.95      0.95      6798
weighted avg       0.95      0.95      0.95      6798
```

Compare prediction accuracy for both of the output feature



	Label 1 (breed_category)	Label 2 (pet_category)
Accuracy	0.931740614	0.952338923
Precision	0.93	0.95
Recall	0.93	0.95

Finally a clean .ipynb file was created with only essential codes to get the output as .csv file

The new new ipynb file named as ‘Final Output.ipynb’

At a glance

- Data pre-processing
  - Redundant feature removal
  - NaN value treatment
  - Outliers and skewness check
  - Class Imbalance removal from output column
- Model Building
  - Multioutput Regression Method
  - Chained Multioutput Regression Method
- Choosing best algorithm
- Applying the algorithm to predict both column one by one

Final Step

- Create a final .ipynb file named 'Final Output.ipynb' to create a .csv file from train data with both of the output features and 'pet_id colum'

[The Decision Tree Classifier Algorithm is used and the predicted output's accuracy is 93% and 95% in the two output feature respectively]

Thank You

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Social Handle

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