Final Project Submission

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- Scheduled Project Review: April 7, 2023
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Binary Classification for Animal Adoption Prediction

Business Understanding

Kaggle PetFinder, 2018
Malaysian Strays, 2021
Poltical Animals,2021
VetFuturist,Unknown

The current goal in is to build models that support predicting if an animal is adoptable or not.

Malaysia's Ministry of Tourism is partnering with the local pet adoption agencies to minimize stray animals in the country. They spend about RM10.3 ($2.3Million) managing pounds and euthanization cost.

Pet Finder supplied data for about 19,000 adoption entries for dogs and cats in each of Malaysias states. The ministry cares about correctly predicting adoptable animals well. The adoptable animals will be prioritized in a shelter or pound. It is not determined what will happen with ther other animals. The Ministry of Tourism has another phase to find the best solutions that utilize the animals and minimizes Euthanasia.

Ministry of Tourism (Main Stakeholder)

- Want to understand which animals are the most adoptable. (Phase 1:Current Model)
  - Because some facilities and labor is already available more cost efficient
  - Knowing adoptable animals will help with facilities, labor and equipment planning.
  - Supports reducing stray population quickly.
  - Help focus rescuers in certain areas.
- Find solutions for the other animals while cutting management, labor and euthanation cost. (Phase 2: TBD)

- Their goal is to improve the safety, attraction of area and soothe political upheival about all the strays.

Adoption Agency (Secondary Stakeholder)

- Minimize Euthenasia and maximize holding animals as long as possible

Assumptions:

- Most cats are more tolerable because of a predominately Islamic and Hindu religion.

Questions:

- What model features are most important?

Metrics:

- Primarily want Precision to maximize TP and minimize FP of adoptees.
- Secondary we want Recall and F1 to minimize FN.

Import Libraries

In [153…

```
#API to get kaggle data
#import kaggle

import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
import seaborn as sns
%matplotlib inline

#Sklearn libraries for most classifier and metrics
import sklearn
from sklearn.model_selection import train_test_split, GridSearchCV, cross_val_s
from sklearn.dummy import DummyClassifier
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
from xgboost import XGBClassifier
from sklearn.metrics import ConfusionMatrixDisplay,classification_report,recall
from sklearn.metrics import precision_score, f1_score,RocCurveDisplay, roc_auc_
from sklearn.metrics import precision_recall_curve,average_precision_score, mak
from sklearn.metrics import PrecisionRecallDisplay, PredictionErrorDisplay
from sklearn.metrics import confusion_matrix as cm
from sklearn import tree
from sklearn.utils.class_weight import compute_class_weight

# For Neural Net
from tensorflow.keras.wrappers.scikit_learn import KerasClassifier
from keras.optimizers import SGD
import tensorflow as tf
```

```
from tensorflow import keras
from tensorflow.keras.metrics import Accuracy,Precision,Recall
from tensorflow.keras import models, layers, optimizers, activations
from tensorflow.keras.layers import Dense, Dropout
from tensorflow.keras.utils import plot_model
import keras
from keras.models import Sequential
from keras.layers import Dense

import warnings
warnings.filterwarnings('ignore')

import time

#Data Imbalance
from imblearn.over_sampling import SMOTE
from imblearn.pipeline import Pipeline as ImPipeline
```

Data Download (w/ API - Optional)

API Download Instructions

Kaggle API Instructions

- **Preconditions**
  - pip install kaggle
  - import kaggle
  - create ".kaggle" folder at root directory
  - have .kaggle.json in .kaggle folder
  - Have an verified account on Kaggle and join the competition
  - Under Account settings Create New API Token
- **Run command from Kaggle Competitions Petfinder Adoption Kaggle Site**
  - "!kaggle competitions download -c petfinder-adoption-prediction "
- Unzip file (Manually or "unzip" utility)
- Make a "data" directory in current directory
- Copy and move the following files to "data" directory a. train folder
  b. test folder
  c. PetFinder-ColorLabels.csv
  d. BreedLabels.csv
  e. ColorLabels.csv
  f. StateLabels.csv

Data Load

Assumes data was downloaded, unzipped to the data folder in current directory.

In [2]:
```
# Import training csv file
org_train_df = pd.read_csv("data/train/train.csv")
test_df = pd.read_csv("data/test/test.csv")
state_df = pd.read_csv("data/StateLabels.csv")
```

```
color_df = pd.read_csv("data/ColorLabels.csv")
breed_df = pd.read_csv("data/BreedLabels.csv")
```

Data Understanding

Data Description,Kamal Khumar, 2021

Dataset Description

Feature	Description	Data Type
Type	Type of Animal (1=Dog,2=Cat)	Nominal Number
Name	Name of Pet (Empty if not named)	String
Age	Age of pet when listed (Months)	Cardinal Number
Breed	Breed1 (Primary breed),Breed2 (Secondary breed, if mixed) (Ref Breedlabels dict)	Nominal Number:String
Gender	Gender of pet 1=Male, 2=Female, 3=Mixed, if profile represents group of pets)	Nominal Number
Color	Colors of pets Ref Colorlabels dict	Nominal Number
Maturity Size	Number of Rooms (1=Sm, 2=Med,3=Lg,4=XLg,0=Not Spec)	Nominal Number
Fur Length	Fur Length (1=Shrt, 2=Med,3=Lg,4=Lng,0=Not Spec)	Nominal Number
Vaccinated	Pet has been vaccinated (1=Yes,2=No,3=Not Sure)	Nominal Number
Dewormed	Pet has been dewormed (1=Yes,2=No,3=Not Sure)	Nominal Number
Sterilized	Pet has been spayed/neutered (1=Yes,2=No,3=Not Sure)	Nominal Number
Health	Health Condition (1=Healthy,2=Minor Inj,3=Serious Inj,0=Not Spec)	Nominal
Quantity	Number of pets represented in profile	Cardinal Number
Fee	Adoption fee (0=Free)	Cardinal Number
state	State location in Malaysia (Ref to StateLabels dict)	Nominal Number

Feature	Description	Data Type
RescuerID	Unique hash ID of rescuer	String
VideoAmt	Total uploaded videos for pet	Cardinal Number
PhotoAmt	Total uploaded videos for pet	Cardinal Number
Description	Profile write-up (Primarily Eng, also Malay or Chinese)	String Object
AdoptionSpreed	Categorical speed of adoption. Lower is faster. (Adopted[0,1,2,3] = 1, Not Adopted[4]=0)	Nominal Number
PetID	Unique hash ID of pet profile	String Object

Exploring Dataset

EDA Cheatsheet Datasans,2022

The dataset from Kaggle had several files that will be used in the modeling effort.

- Training set (14993 entries)
- Test set (3972 entries)
- Breed labels (307 entries)
- Color labels (7 entries)
- State labels (15 entries)

In [3]:
```
#Copy original dataset fo
train_df = org_train_df.copy()
```

In [4]:
```
#Viewing the dataset
train_df.head(5)
```

Out[4]:

	Type	Name	Age	Breed1	Breed2	Gender	Color1	Color2	Color3	MaturitySize	...	Healt
0	2	Nibble	3	299	0	1	1	7	0	1	...	
1	2	No Name Yet	1	265	0	1	1	2	0	2	...	
2	1	Brisco	1	307	0	1	2	7	0	2	...	
3	1	Miko	4	307	0	2	1	2	0	2	...	
4	1	Hunter	1	307	0	1	1	0	0	2	...	

5 rows × 24 columns

In [5]:
```
#Notice the objects, nulls and amount
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14993 entries, 0 to 14992
Data columns (total 24 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Type           14993 non-null  int64
 1   Name           13736 non-null  object
 2   Age            14993 non-null  int64
 3   Breed1         14993 non-null  int64
 4   Breed2         14993 non-null  int64
 5   Gender         14993 non-null  int64
 6   Color1         14993 non-null  int64
 7   Color2         14993 non-null  int64
 8   Color3         14993 non-null  int64
 9   MaturitySize   14993 non-null  int64
 10  FurLength      14993 non-null  int64
 11  Vaccinated     14993 non-null  int64
 12  Dewormed       14993 non-null  int64
 13  Sterilized     14993 non-null  int64
 14  Health         14993 non-null  int64
 15  Quantity       14993 non-null  int64
 16  Fee            14993 non-null  int64
 17  State          14993 non-null  int64
 18  RescuerID      14993 non-null  object
 19  VideoAmt       14993 non-null  int64
 20  Description    14981 non-null  object
 21  PetID          14993 non-null  object
 22  PhotoAmt       14993 non-null  float64
 23  AdoptionSpeed  14993 non-null  int64
dtypes: float64(1), int64(19), object(4)
memory usage: 2.7+ MB
```

There is a mix of ints, floats, and objects. There are only missing values for Names and Descriptions.

In [6]:
```
#Review the training statistics and patterns
train_df.describe()
```

Out[6]:

	Type	Age	Breed1	Breed2	Gender	Color1
count	14993.000000	14993.000000	14993.000000	14993.000000	14993.000000	14993.000000
mean	1.457614	10.452078	265.272594	74.009738	1.776162	2.234176
std	0.498217	18.155790	60.056818	123.011575	0.681592	1.745225
min	1.000000	0.000000	0.000000	0.000000	1.000000	1.000000
25%	1.000000	2.000000	265.000000	0.000000	1.000000	1.000000
50%	1.000000	3.000000	266.000000	0.000000	2.000000	2.000000
75%	2.000000	12.000000	307.000000	179.000000	2.000000	3.000000
max	2.000000	255.000000	307.000000	307.000000	3.000000	7.000000

- Most of animals are puppies or kittens
- There a few outliers for expensive prices, but most are under 30, most are free
- Substantial amount with multiple animals

- Small percentage of animals come with video
- Most animals have an associated picture or multiple
- It seems most animals are not adopted

In [7]:
```
#Understanding of colors
color_df
```

Out[7]:

	ColorID	ColorName
0	1	Black
1	2	Brown
2	3	Golden
3	4	Yellow
4	5	Cream
5	6	Gray
6	7	White

The color account for primary and secondary.

In [8]:
```
#Breed labels
breed_df.head(-1)
```

Out[8]:

	BreedID	Type	BreedName
0	1	1	Affenpinscher
1	2	1	Afghan Hound
2	3	1	Airedale Terrier
3	4	1	Akbash
4	5	1	Akita
...	...	...	...
301	301	2	Tonkinese
302	302	2	Torbie
303	303	2	Tortoiseshell
304	304	2	Turkish Angora
305	305	2	Turkish Van

306 rows × 3 columns

In [9]:
```
# Cat Breeds
(breed_df["Type"] ==2).sum()
```

Out[9]:
```
66
```

Most (241) of the breeds are for Type 1 (Dog).

The breeds account for primary and secondary.

In [10]:
```
#State labels
state_df
```

Out[10]:

	StateID	StateName
0	41336	Johor
1	41325	Kedah
2	41367	Kelantan
3	41401	Kuala Lumpur
4	41415	Labuan
5	41324	Melaka
6	41332	Negeri Sembilan
7	41335	Pahang
8	41330	Perak
9	41380	Perlis
10	41327	Pulau Pinang
11	41345	Sabah
12	41342	Sarawak
13	41326	Selangor
14	41361	Terengganu

In [11]:
```
#Printing out Summary Value Counts for each column in datatrame
for a in train_df.columns:
    print("Value Count of:",a)
    print(train_df[a].value_counts())
    print("\n")
```

```
Value Count of: Type
1    8132
2    6861
Name: Type, dtype: int64


Value Count of: Name
Baby                      66
Lucky                     64
No Name                   54
Brownie                   54
Mimi                      52
                          ..
Maroo                      1
4 PUPPIES FOR ADOPTION     1
Trish                      1
Lab Mix Puppy 2            1
Fili                       1
Name: Name, Length: 9060, dtype: int64


Value Count of: Age
2      3503
1      2304
3      1966
4      1109
12      967
       ...
69        1
74        1
81        1
44        1
100       1
Name: Age, Length: 106, dtype: int64


Value Count of: Breed1
307    5927
266    3634
265    1258
299     342
264     296
       ...
176       1
214       1
125       1
123       1
81        1
Name: Breed1, Length: 176, dtype: int64


Value Count of: Breed2
0      10762
307     1727
266      599
265      321
299      138
       ...
104        1
36         1
```

```
17         1
257        1
279        1
Name: Breed2, Length: 135, dtype: int64


Value Count of: Gender
2    7277
1    5536
3    2180
Name: Gender, dtype: int64


Value Count of: Color1
1    7427
2    3750
3     947
5     884
6     684
7     667
4     634
Name: Color1, dtype: int64


Value Count of: Color2
0    4471
7    3438
2    3313
5    1128
6    1063
4     870
3     710
Name: Color2, dtype: int64


Value Count of: Color3
0    10604
7     3221
5      417
6      378
4      198
3      175
Name: Color3, dtype: int64


Value Count of: MaturitySize
2    10305
1     3395
3     1260
4       33
Name: MaturitySize, dtype: int64


Value Count of: FurLength
1    8808
2    5361
3     824
Name: FurLength, dtype: int64
```

```
Value Count of: Vaccinated
2    7227
1    5898
3    1868
Name: Vaccinated, dtype: int64


Value Count of: Dewormed
1    8397
2    4815
3    1781
Name: Dewormed, dtype: int64


Value Count of: Sterilized
2    10077
1     3101
3     1815
Name: Sterilized, dtype: int64


Value Count of: Health
1    14478
2      481
3       34
Name: Health, dtype: int64


Value Count of: Quantity
1     11565
2      1422
3       726
4       531
5       333
6       185
7        84
8        52
9        33
10       19
20       12
11       10
12        6
15        4
17        3
16        3
14        2
13        2
18        1
Name: Quantity, dtype: int64


Value Count of: Fee
0      12663
50       468
100      408
200      219
150      162
       ...
170        1
135        1
```

```
14         1
89         1
190        1
Name: Fee, Length: 74, dtype: int64


Value Count of: State
41326    8714
41401    3845
41327     843
41336     507
41330     420
41332     253
41324     137
41325     110
41335      85
41361      26
41345      22
41367      15
41342      13
41415       3
Name: State, dtype: int64


Value Count of: RescuerID
fa90fa5b1ee11c86938398b60abc32cb    459
aa66486163b6cbc25ea62a34b11c9b91    315
c00756f2bdd8fa88fc9f07a8309f7d5d    231
b53c34474d9e24574bcec6a3d3306a0d    228
ee2747ce26468ec44c7194e7d1d9dad9    156
                                   ...
89bc6d71d57ad5d7e952ed76559345c5      1
8cfafc812c500eee7c112911ef668ce9      1
8512e22c06a01cdc76481ff0a6e88b67      1
48de9ff092328d54b2b371bc72b07b03      1
79309f4027f2fedb4349a298c69fe56f      1
Name: RescuerID, Length: 5595, dtype: int64


Value Count of: VideoAmt
0    14419
1      417
2       92
3       36
4       15
5        7
6        4
8        2
7        1
Name: VideoAmt, dtype: int64


Value Count of: Description
For Adoption
164
Dog 4 Adoption
54
Cat for adoption
25
Friendly
```

```
20
Please feel free to contact us : Stuart
18

...
We found 2 abandoned litters. Very tiny and fragile. Urgently looking for adop
ters. Please help.
1
This puppy is rescued from Gasing Hill, when we found it, the back of the skin
was ripped off and we took it to the vet immediately, the wound is now a lot b
etter and it needs a home. so any kind person who in interested in adopting a
puppy please contact me. it is a very cute puppy. 24/8/15** update, his wound
has fully recovered and is a healthy puppy!      1
Looking for new family that can spent more time with her. She is very active,
healthy & playful. Listen to basic command such as sit, down & hand. 5kg dog f
ood, toys, two dog bowls and a small dog bag carrier is included. Please conta
ct if interested,
1
If anyone would like to take her,dont be hesitate to contact me before July..n
i looking for person that wants to take Aboo also because this kittens are sib
ling..This little kitten is an active kitten..Her right side of body is black
and left is white..Her face looks like wearing a mask like the zorro.
1
Fili just loves laying around and also loves being under the sun; Very laidbac
k and quiet.
1
Name: Description, Length: 14032, dtype: int64


Value Count of: PetID
86e1089a3    1
aa91c3400    1
a0f76e19b    1
e488a36cf    1
2d5eababe    1
            ..
2275c7ba3    1
f8204bf7c    1
37fdaf339    1
39818f12c    1
a83d95ead    1
Name: PetID, Length: 14993, dtype: int64


Value Count of: PhotoAmt
1.0     3075
2.0     2518
3.0     2511
5.0     2147
4.0     1881
6.0      621
7.0      432
0.0      341
8.0      314
9.0      231
10.0     190
11.0     184
12.0      97
13.0      86
14.0      78
```

```
15.0      50
16.0      39
17.0      27
20.0      25
19.0      20
30.0      19
18.0      18
21.0      16
24.0      15
23.0      12
26.0      10
22.0       9
25.0       8
28.0       7
27.0       6
29.0       6
Name: PhotoAmt, dtype: int64


Value Count of: AdoptionSpeed
4    4197
2    4037
3    3259
1    3090
0     410
Name: AdoptionSpeed, dtype: int64
```

There doesn't seem to be any "odd" value characters except for names.

In [12]:
```
#Checking for Duplicates
train_df.duplicated().sum()
```

Out[12]:
```
0
```

In [13]:
```
#Checking for Null
train_df.isna().sum()
```

Out[13]:
```
Type              0
Name           1257
Age               0
Breed1            0
Breed2            0
Gender            0
Color1            0
Color2            0
Color3            0
MaturitySize      0
FurLength         0
Vaccinated        0
Dewormed          0
Sterilized        0
Health            0
Quantity          0
Fee               0
State             0
RescuerID         0
VideoAmt          0
Description      12
PetID             0
PhotoAmt          0
AdoptionSpeed     0
dtype: int64
```

Due to the goal of this model, name and description will most likely not be used in the predictive modeling. Therefore missing values are not an issue.

Object Understanding

In [14]:
```
#Rescuer ID
train_df["RescuerID"].duplicated().sum()
# Drop, want to focus on the puppy characteristics
```

Out[14]:
```
9398
```

In [15]:
```
#RescuirID Quanitity
train_df.groupby(["RescuerID", "Type"])["Quantity"].count()
```

Out[15]:
```
RescuerID                         Type
0007e457eb0583479bb888d54764911f  2       1
0008ef529da74e9701db7eaaa4d9115a  1       2
000a5830787b64da2d61b0bbceb7676d  2       4
000acff3d6148772579b3e623988131b  1       1
001b9870d4db6d26e2b52520dfbce249  2       1
                                          ..
ffc64c6fa1aff33c6aa6523a12225ec3  2       1
ffd648ffe5e574b912fcb92a8e0d5520  1       2
ffe9d666deaad333538c341dc3a39d9a  1       3
ffed83297757c1c19681024e7ee670aa  1       4
fff59afa6278380c938b2a5880ecae79  2       3
Name: Quantity, Length: 5891, dtype: int64
```

There are a lot of rescuers who have picked up a lot of animals. The rescuers are not a primary factor in this model. If later understanding where are more about the rescue process or metadata, this would be okay to keep.

In [16]:
```
#Check duplicate petIDs = 0
train_df["PetID"].duplicated().sum()
```

Out[16]:
```
0
```

In [17]:
```
#Check duplicate names, if more than emply cells what is it = 5932, not with sa

train_df["Name"].duplicated().sum()
```

Out[17]:
```
5932
```

In [18]:
```
#Looking into name examples
name_df = train_df.groupby("Name", axis=0)
name_df.sum()
```

Out[18]:

Name	Type	Age	Breed1	Breed2	Gender	Color1	Color2	Color
!	1	1	307	307	3	1	2	
! Med Long Fur Kittens	2	6	265	265	3	2	5	
!!! URGENT!!!	2	3	265	0	2	2	4	
!!!!	1	2	307	0	2	2	3	
!!.	1	1	307	307	3	2	3	
...	...	...	...	...	...	...	...	.
ð ¸ð ·ð Take Me PLEASE ð	2	11	265	0	2	1	2	
ð ð ð ð	2	2	266	0	1	6	7	
ð ð Solid Black Kittenð ð	2	2	266	0	1	1	0	
ð ð 3 Kittens & A Mama ð ð	2	2	266	0	2	4	5	
ð °ð ¾88ð ¾ð °FattFatt	1	24	307	218	3	2	4	

9060 rows × 20 columns

Quantity

Checking different conditions to understand Quanity, Animal Type and Adoption Speed.

In [19]:
```
#Checking number of multiples
train_df[(train_df["Quantity"] > 1) & (train_df["Type"] == 1)& (train_df["Adopt
```

Out[19]:

	Type	Name	Age	Breed1	Breed2	Gender	Color1	Color2	Color3	MaturitySize	..
7	1	Siu Pak & Her 6 Puppies	0	307	0	2	1	2	7	2	..
30	1	Benji & Kimi	4	205	218	3	2	7	0	1	..
48	1	Cute Puppies	1	307	0	3	1	2	0	2	..
50	1	Blackie Duo	1	307	141	2	1	0	0	2	..
64	1	Little Yelpers	2	213	307	3	1	3	7	2	..
...	...	...	...	...	...	...	...	...	...	...	..
14872	1	Charlie's Angels~	1	307	0	2	1	7	0	2	..
14879	1	Toby RIP Zoe Sammy Adpt Holly Hazel Mia	2	307	0	3	1	2	7	2	..
14890	1	Lovely Happy Puppies :))	2	307	0	3	1	4	0	2	..
14908	1	FIDO, LUNA & MOLEX	4	307	0	3	3	0	0	2	..

	Type	Name	Age	Breed1	Breed2	Gender	Color1	Color2	Color3	MaturitySize	..
14970	1	KL Puppies For Adoption	2	307	0	2	2	5	0	2	..

964 rows × 24 columns

In [20]:
```
train_df[(train_df["Quantity"] > 1) & (train_df["Type"] == 2)& (train_df["Adopt
```

Out[20]:

	Type	Name	Age	Breed1	Breed2	Gender	Color1	Color2	Color3	MaturitySize
13	2	2 Mths Old Cute Kitties	2	265	0	3	1	6	7	1
33	2	NaN	4	266	0	2	1	6	7	1
41	2	Drax Aka Fatso, Quill & Rocket	1	266	0	3	1	2	7	1
42	2	Novy	24	292	285	2	7	0	0	2
55	2	Kitties	3	265	0	3	4	6	7	1
...	...	...	...	...	...	...	...	...	...	...
14936	2	Kitten	2	292	0	3	2	5	0	1
14976	2	Cici N Shelly	84	264	264	3	1	7	0	2
14982	2	â ªMami's Babies â ª	2	266	0	2	1	4	7	2
14988	2	NaN	2	266	0	3	1	0	0	2
14990	2	Monkies	2	265	266	3	5	6	7	3

1347 rows × 24 columns

In [21]:
```
pd.crosstab(train_df["Breed1"],train_df["Quantity"])
```

Out[21]:

Quantity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
Breed1																			
0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
303	35	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304	5	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
305	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
306	45	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
307	4630	483	227	187	140	105	52	39	29	8	7	4	1	1	1	2	3	0	8

176 rows × 19 columns

In [22]:

```
# Count how many animals are from each state
np.round(pd.pivot_table(train_df, values = "Quantity", sort=True,
                        index = ["State","Type"],aggfunc=np.sum))
```

Out[22]:

State	Type	Quantity
41324	1	133
	2	72
41325	1	68
	2	95
41326	1	7247
	2	6211
41327	1	937
	2	403
41330	1	529
	2	168
41332	1	392
	2	214
41335	1	65
	2	91
41336	1	462
	2	414
41342	1	9
	2	18
41345	1	7
	2	26
41361	1	3
	2	28
41367	1	3
	2	20
41401	1	2558
	2	3447
41415	1	3
	2	7

- **25 percent of the multiple groups have been adopted.**
- **3428 values greater than one**
- **Two states account for the majority of entries**
- **Assumption: Will assume entries with more than one has a quanity are adopted at the same speed and the attribute descriptions apply to each animal. This is the**

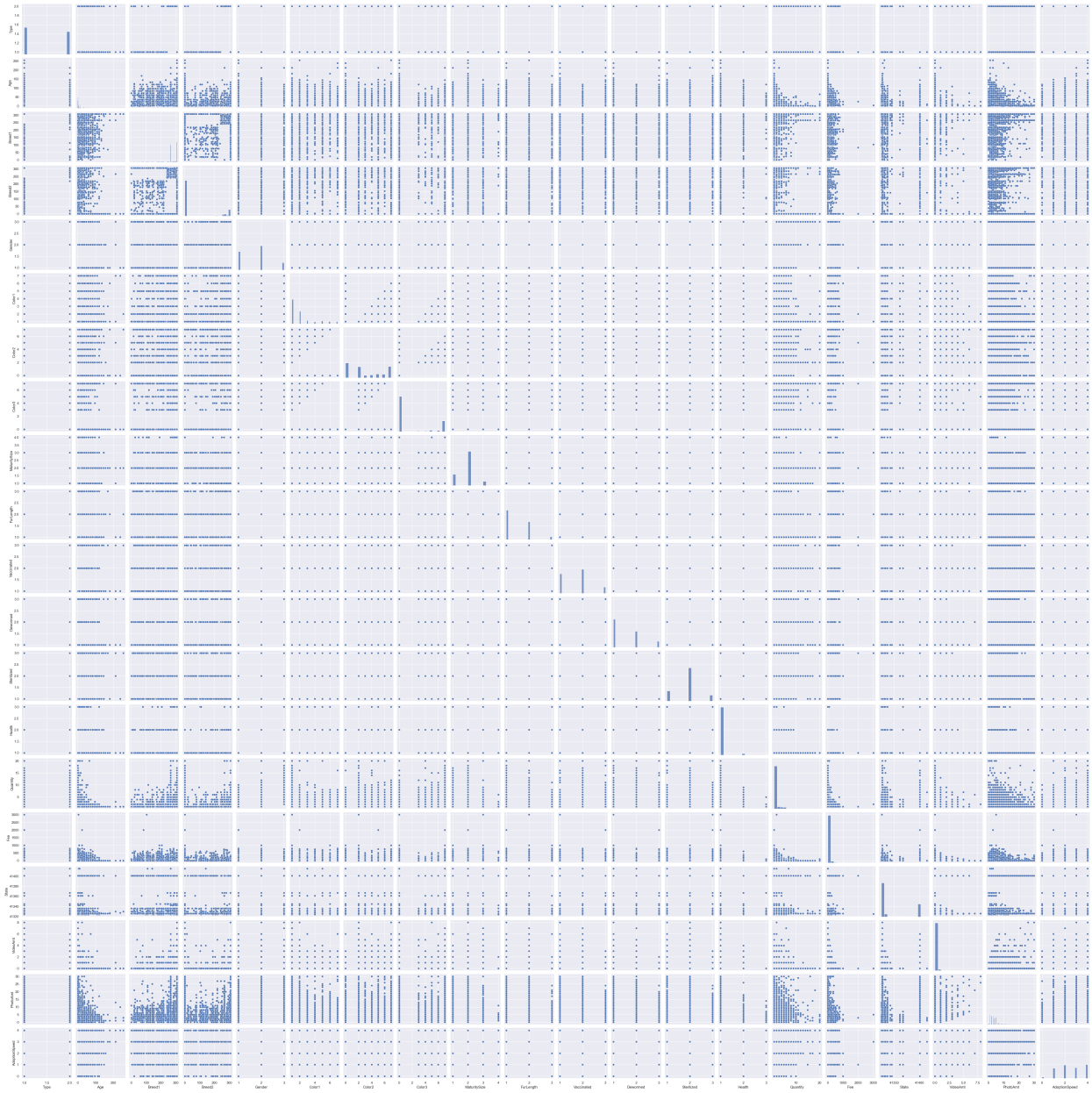
best assumption for the prediciton and analysis.

Data Visualizations

In [23]:
```
# Cite
#https://www.kaggle.com/code/yashvi/car-price-prediction-eda-rfe-with-random-fo
#Multiple https://www.kaggle.com/code/ash316/eda-to-prediction-dietanic
#Different Sns plots: https://towardsdatascience.com/14-data-visualization-plot
#https://jakevdp.github.io/PythonDataScienceHandbook/04.14-visualization-with-s
```

In [24]:
```
#Pair plot for quick view of the datasets distribution
sns.set(rc={'figure.figsize':(20,20)})
sns.pairplot(train_df)
```

Out[24]:
```
<seaborn.axisgrid.PairGrid at 0x2cf901ae0>
```



Correlation

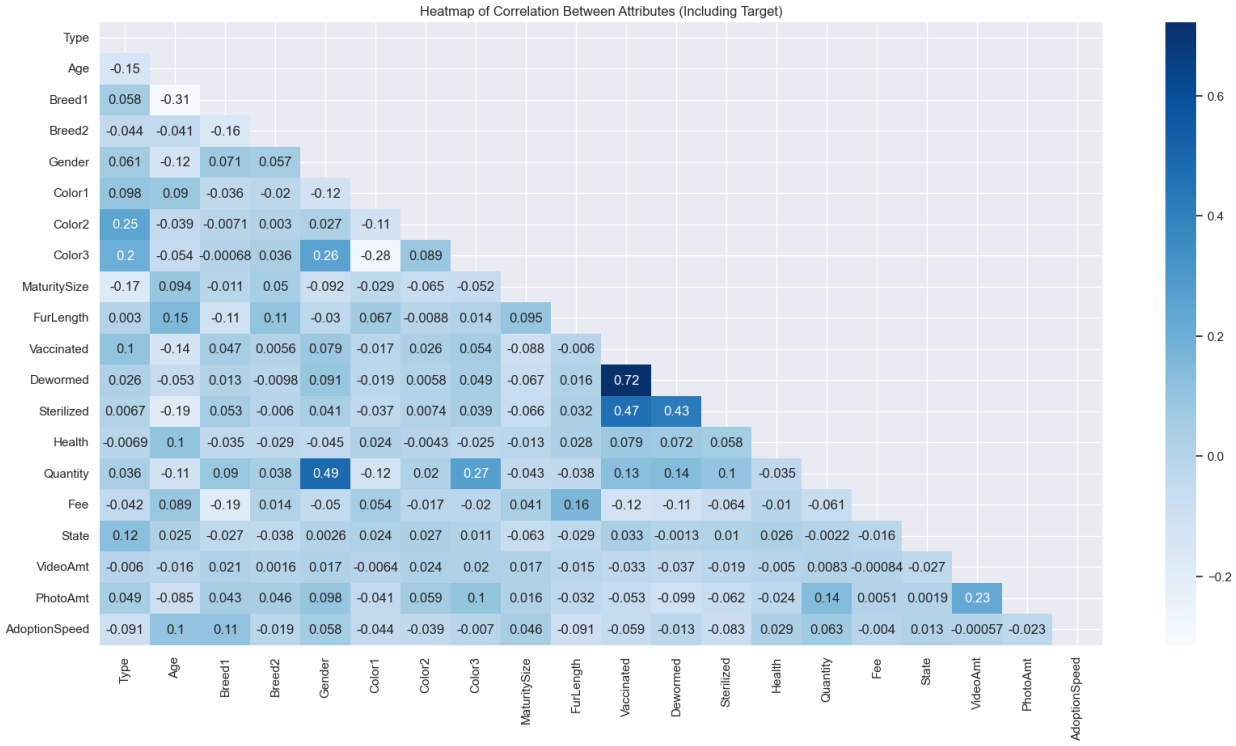
In [25]:
```
#Print out correlation values in dataframe
corr = train_df.corr()
corr
```

Out[25]:

	Type	Age	Breed1	Breed2	Gender	Color1	Co
Type	1.000000	-0.147162	0.057724	-0.043568	0.060843	0.097680	0.246
Age	-0.147162	1.000000	-0.314346	-0.041010	-0.123423	0.090378	-0.039
Breed1	0.057724	-0.314346	1.000000	-0.157053	0.071321	-0.035510	-0.007
Breed2	-0.043568	-0.041010	-0.157053	1.000000	0.056907	-0.020324	0.003
Gender	0.060843	-0.123423	0.071321	0.056907	1.000000	-0.115351	0.026
Color1	0.097680	0.090378	-0.035510	-0.020324	-0.115351	1.000000	-0.113
Color2	0.246333	-0.039427	-0.007081	0.003015	0.026507	-0.113290	1.000
Color3	0.201693	-0.053546	-0.000682	0.035679	0.259309	-0.282897	0.088
MaturitySize	-0.171811	0.093673	-0.010507	0.049879	-0.091819	-0.029468	-0.065
FurLength	0.003036	0.153092	-0.108059	0.106220	-0.030404	0.066967	-0.008
Vaccinated	0.102907	-0.136061	0.046518	0.005638	0.078702	-0.017475	0.026
Dewormed	0.025508	-0.053360	0.013216	-0.009817	0.091431	-0.019318	0.005
Sterilized	0.006737	-0.189450	0.052698	-0.005989	0.040645	-0.037050	0.007
Health	-0.006864	0.103215	-0.034893	-0.029285	-0.045177	0.024410	-0.004
Quantity	0.036423	-0.113076	0.090194	0.038125	0.494489	-0.116688	0.019
Fee	-0.042134	0.089168	-0.189526	0.013508	-0.050491	0.054180	-0.017
State	0.124549	0.024523	-0.026832	-0.037993	0.002564	0.024012	0.026
VideoAmt	-0.005967	-0.015969	0.020626	0.001569	0.016816	-0.006435	0.023
PhotoAmt	0.049368	-0.084778	0.043395	0.045953	0.098435	-0.041323	0.059
AdoptionSpeed	-0.091240	0.100510	0.107834	-0.018642	0.057622	-0.044192	-0.038

In [26]:
```
# Set up figure and axes
fig, ax = plt.subplots(figsize=(20,10),facecolor = "white")

# Plot a heatmap of the correlation matrix, with both
# numbers and colors indicating the correlations
sns.heatmap(
    # Specifies the data to be plotted
    data=corr,
    # The mask means we only show half the values,
    # instead of showing duplicates. It's optional.
    mask=np.triu(np.ones_like(corr, dtype=bool)),
    # Specifies that we should use the existing axes
    ax=ax,
    #Color of the heatmap
    cmap="Blues",
    # Specifies that we want labels, not just colors
    annot=True,

)
```

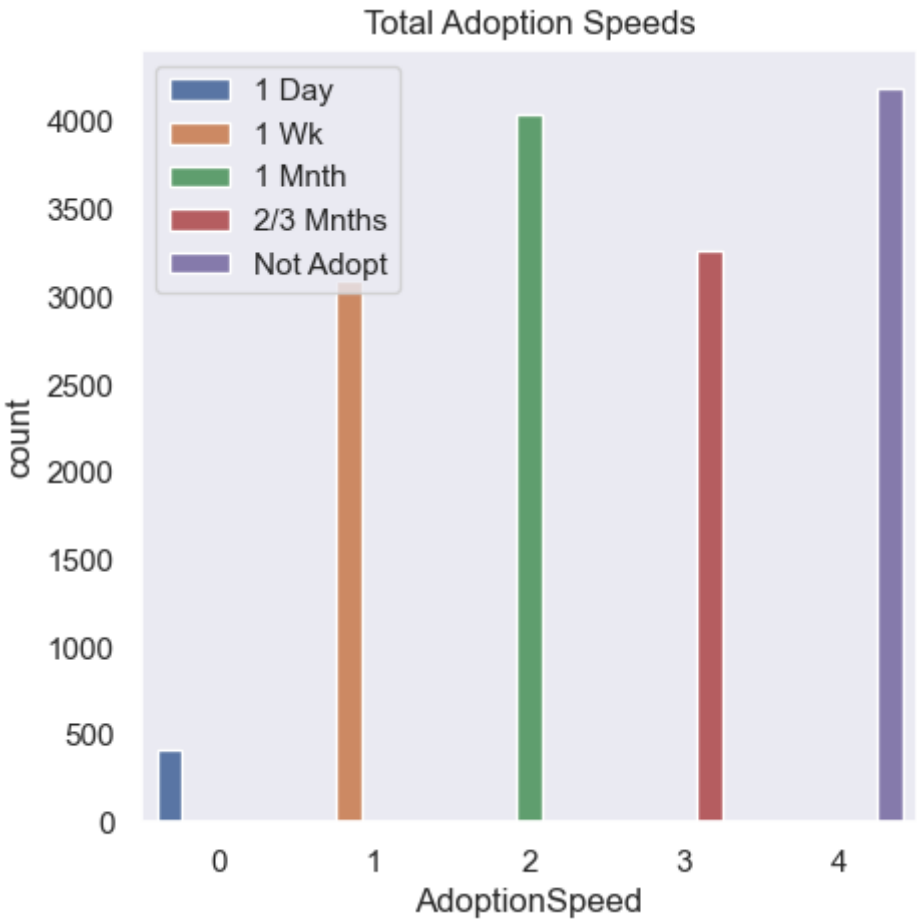
```
# Customize the plot appearance
ax.set_title("Heatmap of Correlation Between Attributes (Including Target)");
```



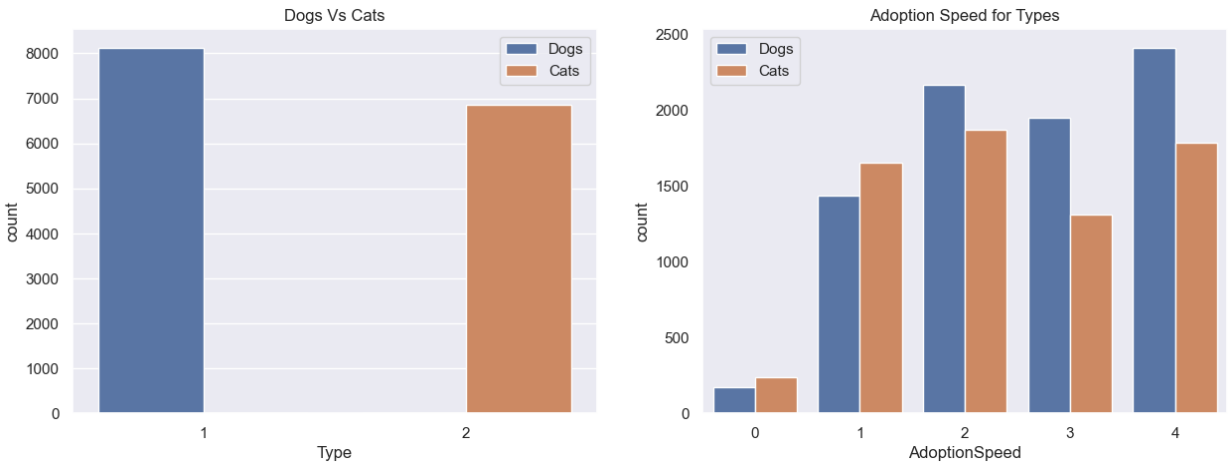
- Age, Breed1, MaturitySize, Gender and Quanity have the highest correlation with adoptionspeed. Further understanding will be done on these features
- Expecting different correlations being more important like type, breed, color, pictures and health.
- Most of the other features have a weak correlation, which is suprising.
- Will drop Dewormed.

Adoption Speeds

In [27]:
```
#Adoption Speeds
fig,ax = plt.subplots(figsize = (5,5))
a = sns.countplot(data = train_df, x ="AdoptionSpeed",  hue = "AdoptionSpeed",
ax.set_title("Total Adoption Speeds")
ax.legend(["1 Day","1 Wk", "1 Mnth", "2/3 Mnths", "Not Adopt"])
ax.grid(which ="both", axis = "y")
```



In [28]:
```
#Plot Cats versus dogs and adoption
fig,ax = plt.subplots(1,2,figsize =(15,5))

sns.countplot(x = "Type",hue = "Type", data = train_df, ax =ax[0])
ax[0].set_title("Dogs Vs Cats")
ax[0].legend(["Dogs","Cats"])

cplot = sns.countplot(x = "AdoptionSpeed",hue = "Type", data = train_df, ax =ax
ax[1].set_title("Adoption Speed for Types")
ax[1].legend(["Dogs","Cats"])
ax[1].grid(which ="both", axis = "y")
```



There are slightly more dog entries than cats. Cats are adopted faster (within one month),Dogs are adopted around month 1-3 or not at all.

In [29]:
```
#Age and Adoptionspeed Crosstab
pd.crosstab(train_df["AdoptionSpeed"], train_df["Age"])
```

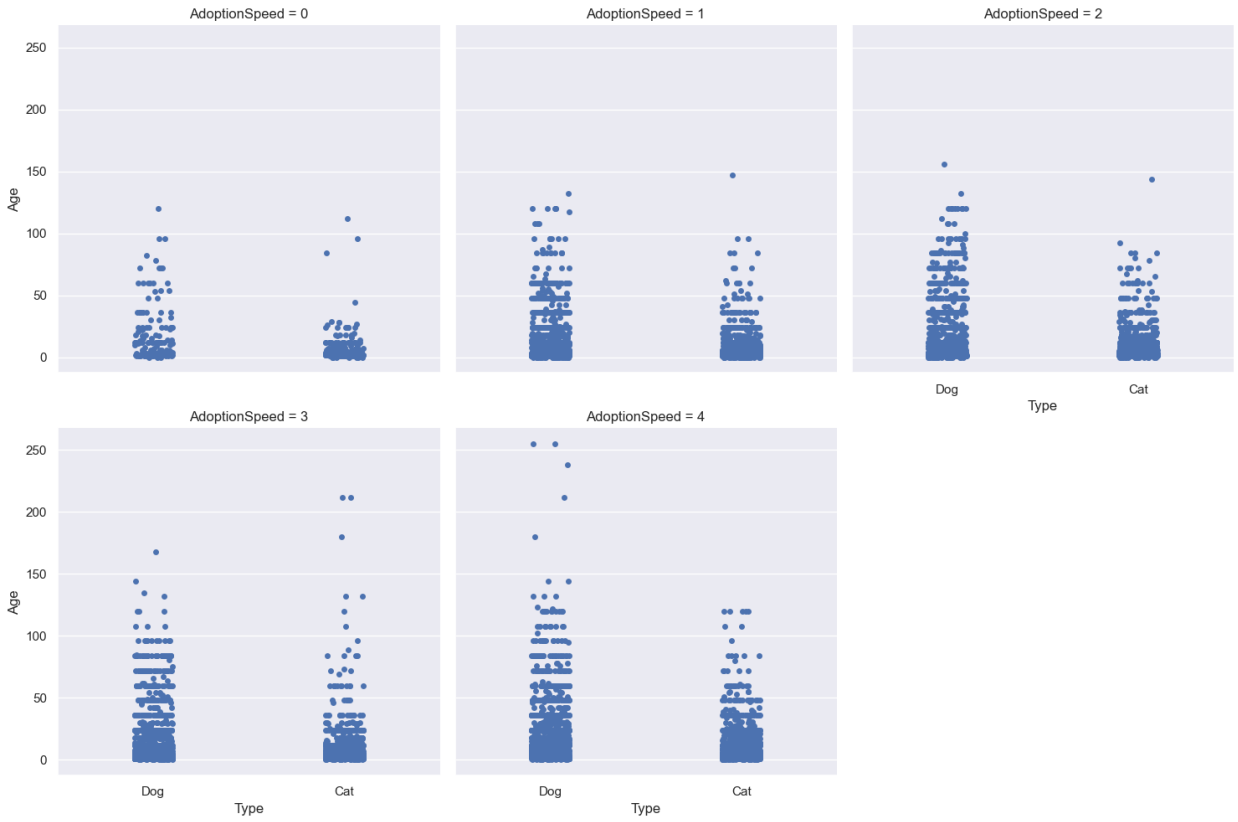
Out[29]:

Age	0	1	2	3	4	5	6	7	8	9	...	132	135	144	147	1
AdoptionSpeed																
0	10	54	115	44	24	7	20	7	4	5	...	0	0	0	0	
1	50	643	865	408	211	100	80	43	36	24	...	1	0	0	1	
2	44	754	1120	586	265	157	117	59	68	51	...	1	0	1	0	
3	39	511	783	458	260	135	115	62	70	31	...	3	1	1	0	
4	36	342	620	470	349	196	226	110	131	73	...	3	0	2	0	

5 rows × 106 columns

In [30]:
```
#Exploring Age and Gender
ag = sns.catplot(data = train_df, y = "Age", x = "Type", col_wrap = 3, col = "A
ag.set_xticklabels(["Dog","Cat"])
```

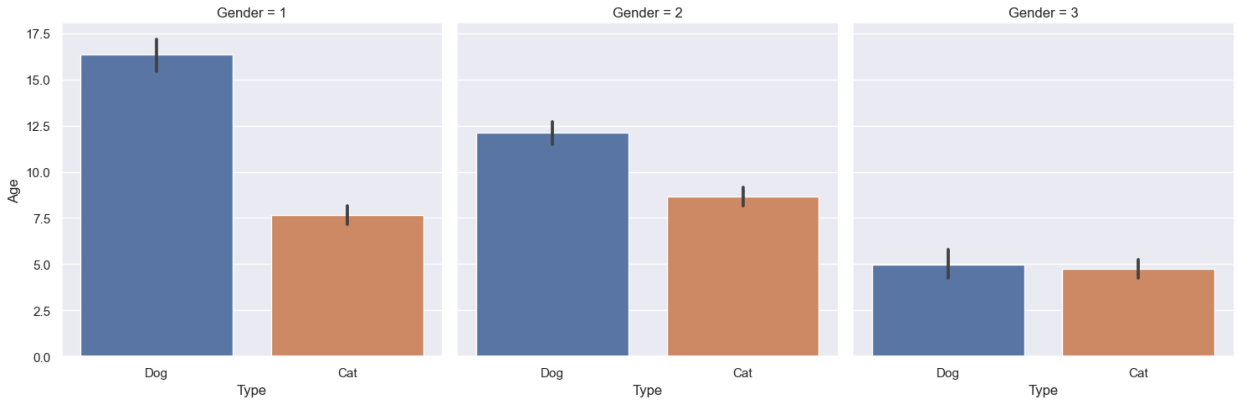
Out[30]:
```
<seaborn.axisgrid.FacetGrid at 0x30fa2ad40>
```



Puppies and kittens are adopted at the various rates and not adopted. The old dogs aren't usually adopted.

In [31]:
```
#Age, Type, Gender
ag = sns.catplot(data = train_df, y = "Age", x = "Type", col = "Gender", kind =
ag.set_xticklabels(["Dog","Cat"])
```

Out[31]: <seaborn.axisgrid.FacetGrid at 0x2fdc24fd0>



The gender by type are proportional to the animal type splits. Gender 3 indicates an entry with multiple quantities.

In [32]:
```
#Looking at how animals are listed
pd.crosstab(train_df["AdoptionSpeed"], train_df["Breed1"])
```

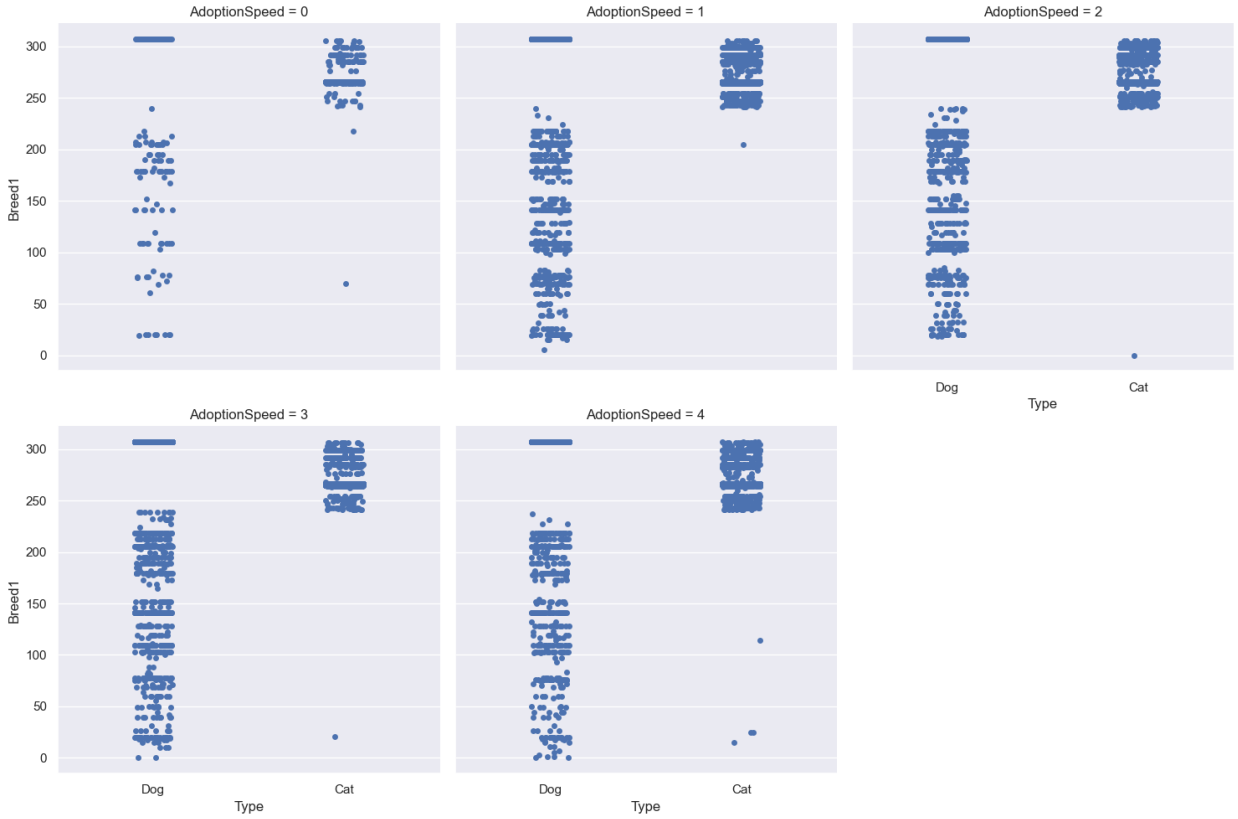
Out[32]:

Breed1	0	1	3	5	7	10	11	15	16	17	...	298	299	300	301	302	303	304	3
AdoptionSpeed																			
0	0	0	0	0	0	0	0	0	0	0	...	1	10	1	0	0	2	0	
1	0	0	0	1	0	0	0	3	0	1	...	0	82	5	3	0	8	0	
2	1	0	0	0	0	0	0	0	0	0	...	0	95	6	1	1	17	4	
3	2	0	0	0	0	3	0	3	0	3	...	0	64	3	1	0	4	0	
4	2	2	1	1	1	0	2	3	1	2	...	0	91	6	0	0	11	3	

5 rows × 176 columns

In [33]:
```
#"Primary Breed by Adoption Speed for Dogs and Cats"
ag = sns.catplot(data = train_df, y = "Breed1", x = "Type",col_wrap = 3, col =
ag.set_xticklabels(["Dog","Cat"])
```

Out[33]: <seaborn.axisgrid.FacetGrid at 0x2febab190>



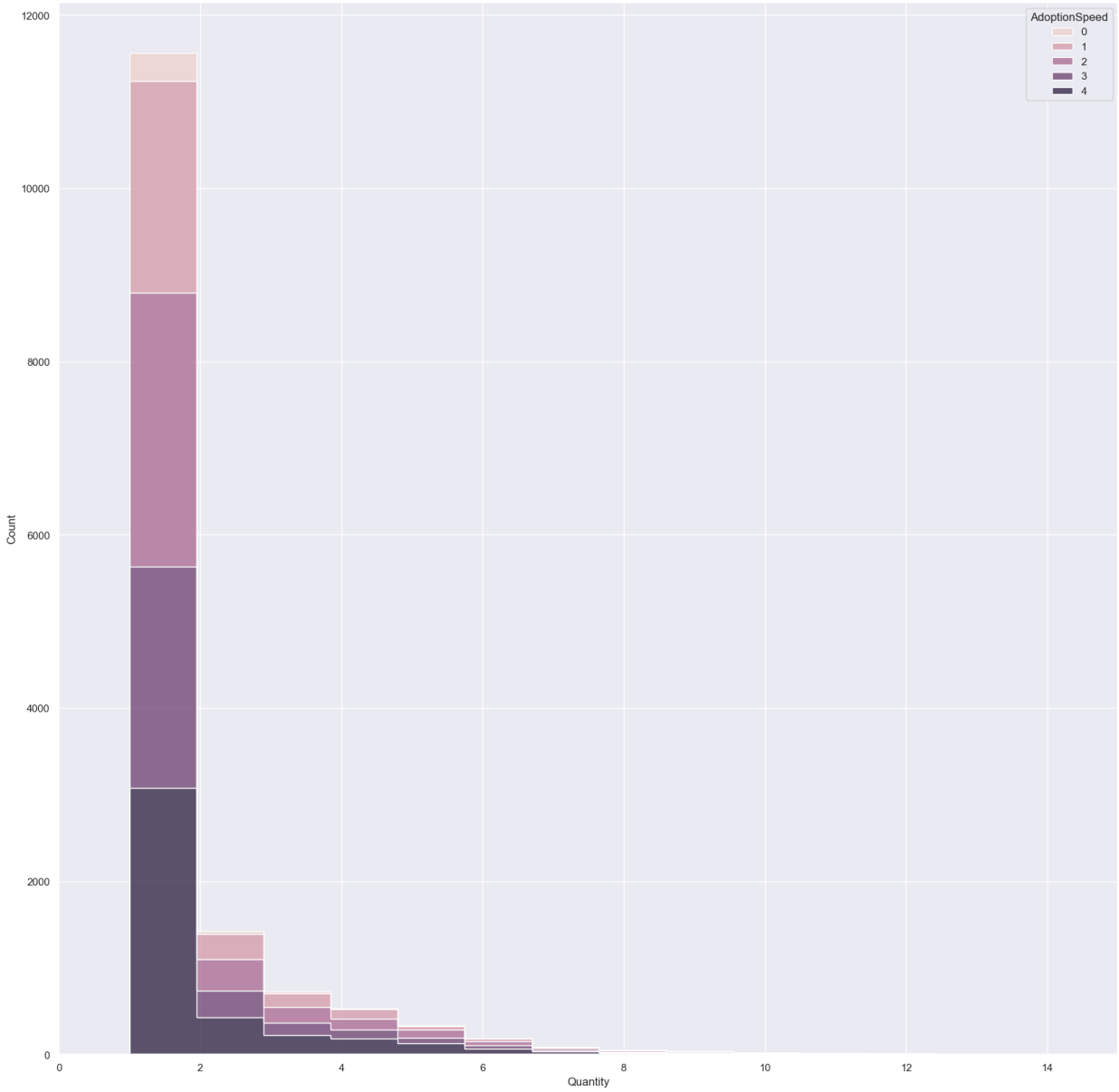
In [34]:
```
#Looking at how animals are listed
pd.crosstab(train_df["AdoptionSpeed"], train_df["Quantity"])
```

Out[34]:

Quantity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
AdoptionSpeed																		
0	331	35	20	13	7	1	0	2	0	1	0	0	0	0	0	0	0	0
1	2439	290	158	106	42	29	11	7	4	2	0	0	0	0	1	0	0	0
2	3163	362	181	129	90	51	22	15	9	3	3	2	1	0	0	2	2	0
3	2552	307	148	97	65	38	21	12	11	2	1	2	0	0	1	0	1	0
4	3080	428	219	186	129	66	30	16	9	11	6	2	1	2	2	1	0	1

In [35]:
```
#AdoptionSpeed, Quantity Histogram
ag = sns.histplot(data = train_df,x  = "Quantity",hue = "AdoptionSpeed",multipl
ag.set(xlim = (0,15))
```

Out[35]:
```
[(0.0, 15.0)]
```

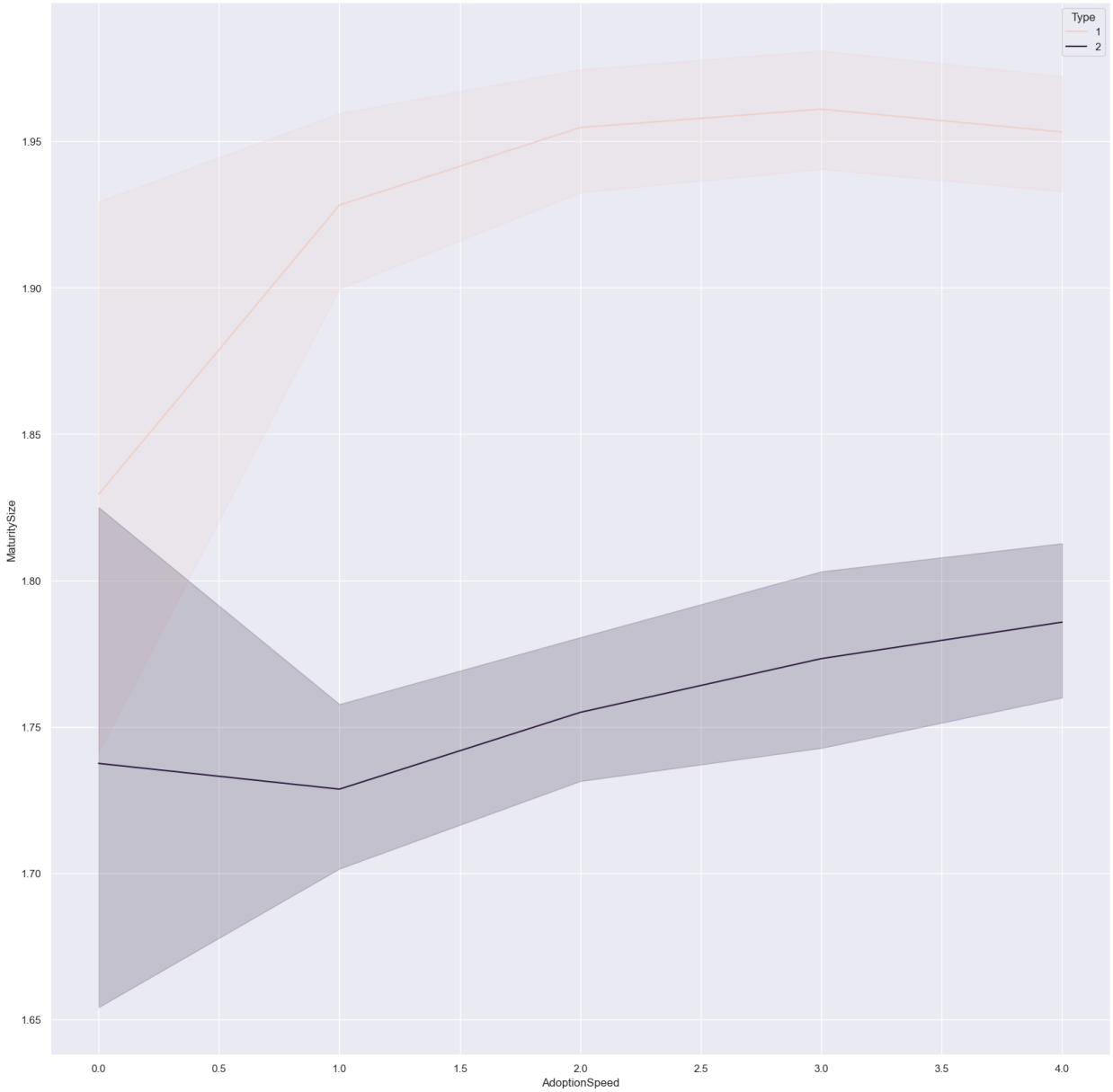


Most adoptions and non adoptions are from an entry with a quanity of one. The more the quantity this value decreased

---

Vaccination and Deworking Colinearity

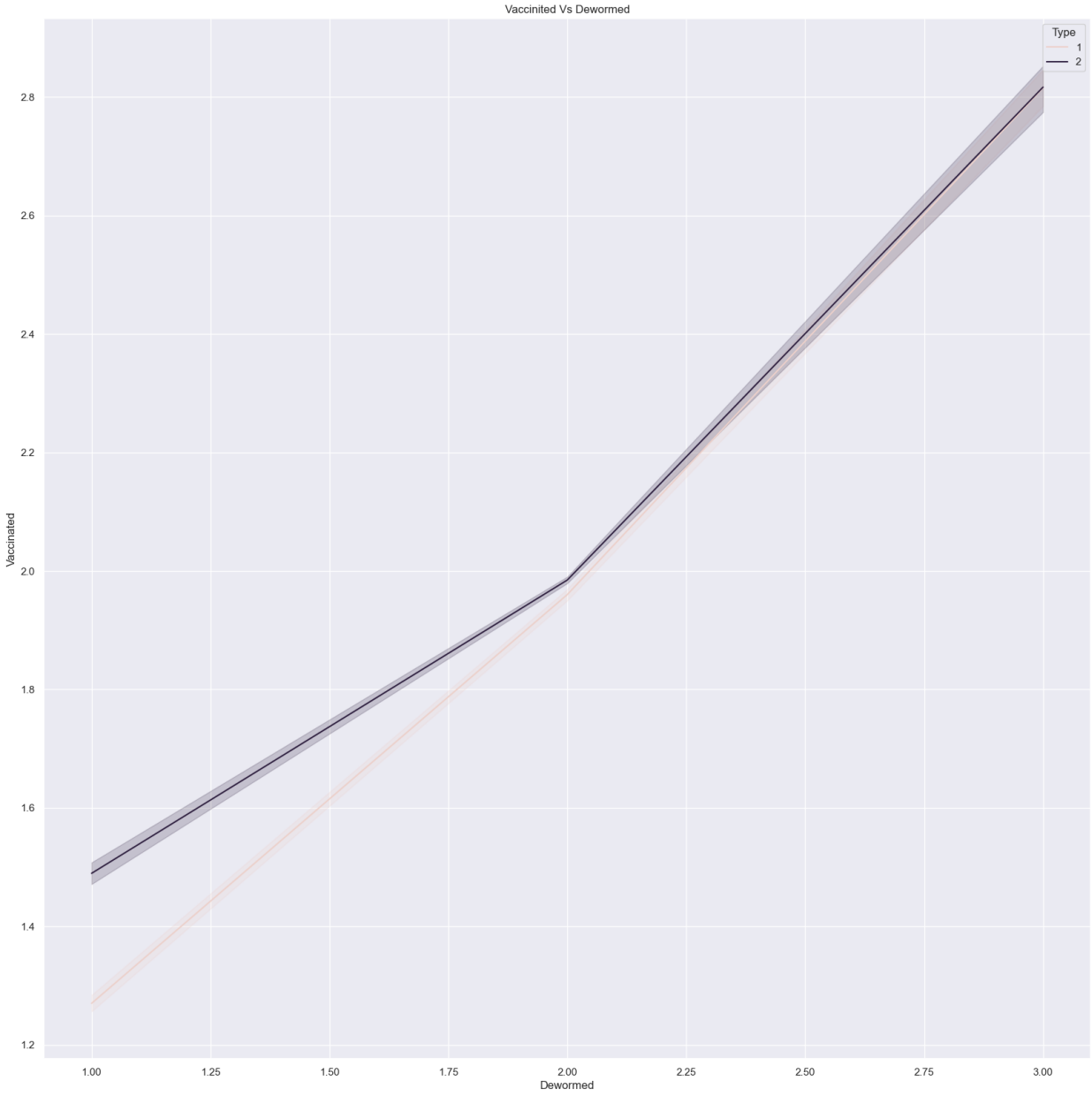
In [36]:
```
#Vaccinated by Deworm
ag = sns.lineplot(data = train_df, y = "MaturitySize", hue = "Type", x="Adoptic
```



Most kittens are adopted when they are smalled. Dogs start of being adopted at a larger size.

In [37]:
```
#Vaccinated by Deworm
ag = sns.lineplot(x = "Dewormed",y = "Vaccinated", hue= "Type", data = train_df
ag.set_title("Vaccinited Vs Dewormed")
```

Out[37]:
```
Text(0.5, 1.0, 'Vaccinited Vs Dewormed')
```



The relationship between deworming and vaccination is almost linear for both animals. Dewormed can be dropped.

Data Preparation

In [38]:
```
#Change PhotoAmt to int64, if float it should round numbers to whole number
train_df["PhotoAmt"] = train_df["PhotoAmt"].astype("int64", errors='ignore')
train_df["PhotoAmt"].dtype
```

Out[38]:
```
dtype('int64')
```

Rationale for dropping:

- **Description best if analyzed looking for keywords using NLP Limitation**

- Name best if analyzed looking for keywords using NLP, too many unique names and odd characters...best to drop than guessing
- Limitation, wont be used in prediction, but after seeing results, check the names for that they are...low fidelity correlation
- Because the id is an and not a specific name of a person, drop for prediction, there are over 5000 rescuers, there are

In [39]:
```
#Create a new dataframe for dropped tracks for end evaluation
drop_df =train_df[["Name","Description","RescuerID","PetID","Dewormed"]].copy()

#Drop uneeded columns
main_df = train_df.drop(columns=["Name","Description","RescuerID","PetID"], axi
```

Binary Classification: The main goal is to understand if an animal will be adopted or not. Therefore this will turn into a binary classification problem. All the categtories from (0,3) will be converted to a 1 representing adoption. Category number 4 will be converted to 0, representing no adoption.

In [40]:
```
#Convert target variable to two types 1- Adopted, 0- Not Adopted (Old 3 or less

main_df["AdoptionSpeed"] = main_df["AdoptionSpeed"].replace([0,1,2,3],1)
main_df["AdoptionSpeed"] = main_df["AdoptionSpeed"].replace([4],0)
main_df["AdoptionSpeed"].value_counts()
```

Out[40]:
```
1    10796
0     4197
Name: AdoptionSpeed, dtype: int64
```

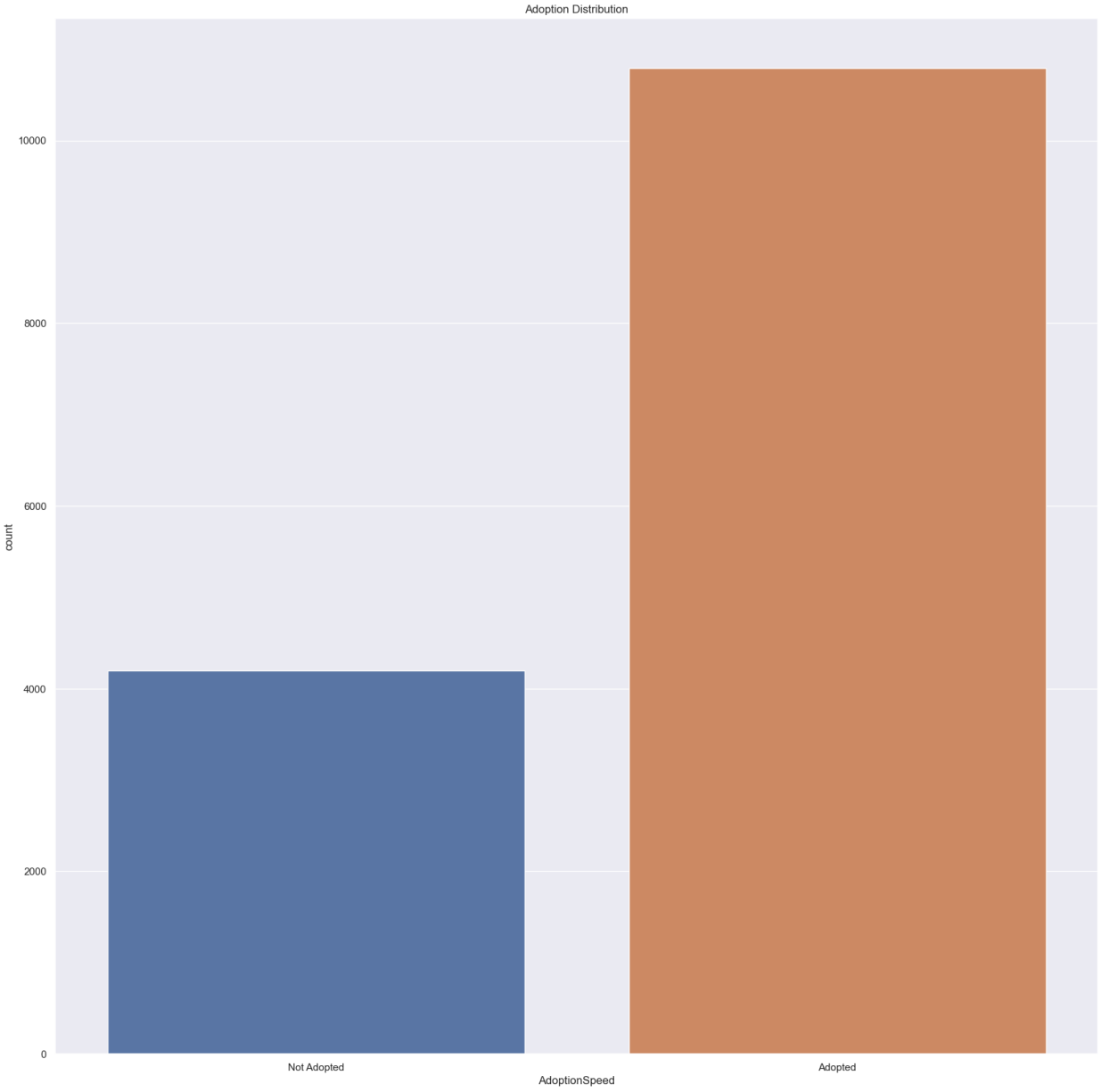
In [41]:
```
#Train Test Split of the Data for Modeling
X = main_df.drop("AdoptionSpeed", axis = 1)
y = main_df["AdoptionSpeed"]
X_train, X_test, y_train, y_test = train_test_split(X,y, random_state = 42, str
```

In [42]:
```
#Checking to see if the value counts are stratified for imbalance
print(y_train.value_counts())
print(y_test.value_counts())
```

```
1    8096
0    3148
Name: AdoptionSpeed, dtype: int64
1    2700
0    1049
Name: AdoptionSpeed, dtype: int64
```

In [43]:
```
#Exploring Age and Gender
ag = sns.countplot(data = main_df,x = "AdoptionSpeed")
ag.set_xticklabels(["Not Adopted","Adopted"])
ag.set_title("Adoption Distribution")
```

Out[43]:
```
Text(0.5, 1.0, 'Adoption Distribution')
```



Modeling

Main Functions

In [44]:
```
#Fit and predict with an instatiated model
def fit_pred(instatiated_model,X_train=X_train, X_test = X_test):
    """ This function takes an instatiated model fits it then predicts the trai
    The prediction and prediction probabilities are returned for the train and
    #Fit training data
    instatiated_model.fit(X_train,y_train)
    #Predict with Train
    y_train_pred = instatiated_model.predict(X_train)
    y_train_pred_prob  = instatiated_model.predict_proba(X_train)
    #Predict with Test
    y_test_pred = instatiated_model.predict(X_test)
    y_test_pred_prob  = instatiated_model.predict_proba(X_test)
```

```
    return  y_train_pred, y_train_pred_prob,y_test_pred, y_test_pred_prob
```

In [45]:
```
#Calculating precision, recall, f1, acc
def calc_metrics(y_true,y_pred):
    """ Calculates and returns precision, recall, f1, acc metrics from the true
    y_pred = np.round(y_pred,0)
    precision = precision_score(y_true, y_pred)
    recall = recall_score(y_true, y_pred)
    f1 = f1_score(y_true, y_pred)
    acc = accuracy_score(y_true, y_pred,normalize = True)

    print ("The Precision mean score is: {}".format(np.round(precision,2)))
    print ("The Recall mean score is: {}".format(np.round(recall,2)))
    print ("The F1  score is: {}".format(np.round(f1,2)))
    print ("The Accuracy mean score is: {}".format(np.round(acc,2)))
    print("\n")
    return precision, recall, f1, acc
```

In [46]:
```
def conf_matrix(y_true,y_pred):
    """Prints confusion matrix for the Adopted and Not adopted true and predict
    y_pred = np.round(y_pred,0)
    fig, ax = plt.subplots(1,2, figsize = (15,4), facecolor = "white")

    ax[0].set_title("Confusion Matrix")
    ConfusionMatrixDisplay.from_predictions(y_true, y_pred, normalize=None, dis
    ax[1].set_title("Confusion Matrix: Normalized")
    ConfusionMatrixDisplay.from_predictions(y_true, y_pred, normalize="all", di
    ax[0].grid(False)
    ax[1].grid(False)
```

In [47]:
```
#Printing metric subplots of training and validation per epoch
def nn_eval_metrics(history):
    """ Plots Train and Validation metrics["acc","loss","recall","precision"]
    from a model's evaluation results."""

    fig, ax = plt.subplots(1,4, figsize = (25,5))
    fig.suptitle('Model Metrics Results')

    metrics = ["recall","acc","loss","precision"]

    for i, metric in enumerate(metrics):

        ax[i].plot(history.history[metric])
        ax[i].plot(history.history["val_" + metric])
        ax[i].set_title('Model {}'.format(metric))
        ax[i].set_ylabel(metric)
        ax[i].set_xlabel("Epochs")
        ax[i].legend(['train', 'val'])
```

In [48]:
```
def plot_curves(estimator,X,y):
    """Plot the ROC Curve and the Precision Recall Curve.
    These are plotted against the orinal dummy classifier"""
    fig, ax = plt.subplots(1,2, figsize = (10,4), facecolor = "white")
    ax[0].set_title("Precision Recall Curve")
    PrecisionRecallDisplay.from_estimator(estimator,X,y,ax = ax[0])
    PrecisionRecallDisplay.from_estimator(dummy_clf,X,y,ax = ax[0])
    ax[1].set_title("ROC Curve")
```

```
    RocCurveDisplay.from_estimator(estimator,X,y, ax = ax[1])
    RocCurveDisplay.from_estimator(dummy_clf,X,y, ax = ax[1])
```

Model Iteration Sequence

- **Dummy Model**
- **Baseline**
  - **Logistic Regression**
  - **KNN**
  - **XGBoost**
  - **Randon Forest**
  - **Neural Net**
- **Pipeline (Scaled and Smoted)and GridsearchCV**
  - **Logistic Regression**
  - **KNN**
  - **XGBoost**
  - **Randon Forest**
  - **Neural Net**
- **Feature Importance**
- **Final Model Metrics**

Change for Classification Model

The following is the outline of each model iteration:

- **Sequence***
- **Compile***
- **Fit**
- **Predict**
- **Eval report***
- **Conf_matrix**
- **Classification_Report**
- **AUC/ROC & Precision/Recall Curve (Except NN Modeling)**
- **Model Evaluation**

***Neural Net Only**

Each iteration will have slight changes for improvement. They will be described more at the General descriptions of specific iterations.

The main metrics focused on are:

- **Primarily want Precision to maximize TP and minimize FP of adoptees.**

- **Secondary we want Recall and F1 to minimize FN.**
- **Due to a data imbalance the Precision/Recall curve will be used primarily.**

In [49]:
```
# Think About
# calculate precision-recall curve for different thresholds
#precision, recall, thresholds = precision_recall_curve(testy, probs) https://m
```

Dummy Classifier- Abiheet Sahoo, 2020

Dummy Model

Initial understanding of what would guess randomly based on the frequency of data to set a low level baseline for the other models.

In [50]:
```
## Dummy Model
#Instantiating and fitting the model
dummy_clf = DummyClassifier(strategy="most_frequent") # Using Most Frequent str
dummy_clf.fit(X_train, y_train)
```

Out[50]:
```
DummyClassifier(strategy='most_frequent')
```

In [51]:
```
dummy_train_pred,_,dummy_test_pred,_= fit_pred(dummy_clf)
```

In [52]:
```
#Cross Val results on training data
cv_results = cross_val_score(dummy_clf, X_train, y_train, cv=5)
cv_results.mean()
```

Out[52]:
```
0.7200284744979579
```

In [53]:
```
cv_results = cross_val_score(dummy_clf, X_test, y_test, cv=5)
cv_results.mean()
```

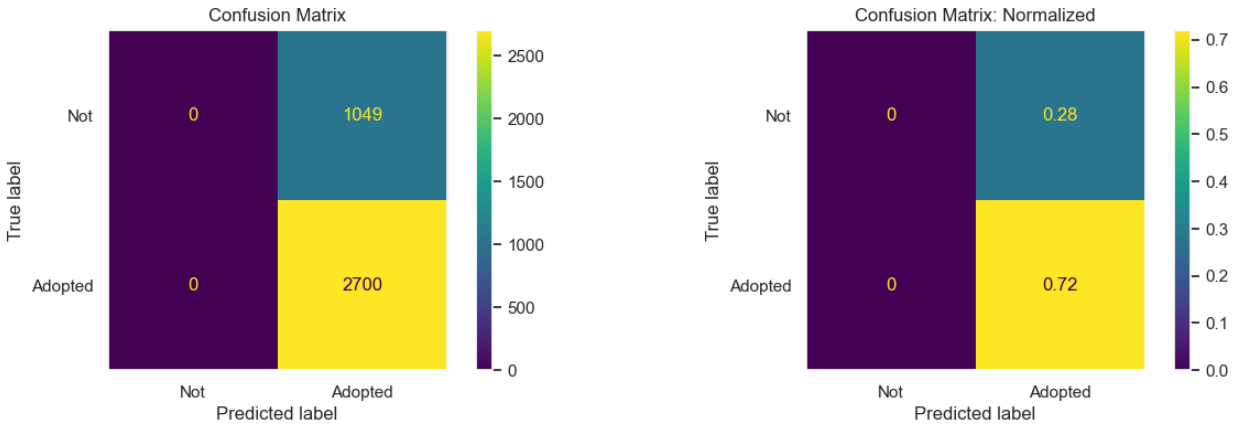
Out[53]:
```
0.720192256341789
```

In [54]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,dummy_tra
print("Test Classification Report:\n", classification_report(y_test, dummy_test
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.00      0.00      0.00      3148
           1       0.72      1.00      0.84      8096

    accuracy                           0.72     11244
   macro avg       0.36      0.50      0.42     11244
weighted avg       0.52      0.72      0.60     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.00      0.00      0.00      1049
           1       0.72      1.00      0.84      2700

    accuracy                           0.72      3749
   macro avg       0.36      0.50      0.42      3749
weighted avg       0.52      0.72      0.60      3749
```

In [55]:
```
print("Test Confusion Matrix:\n")
conf_matrix(y_test,dummy_test_pred)
```

```
Test Confusion Matrix:
```



Model Evaluation

- ~72% Change of predicting if an animal will be adopted on random guessing.

Baseline Logistic Regression

In [56]:
```
#Instantiate
lr_simple = LogisticRegression(random_state = 42,penalty= "none")
#Fit and Predict
lr_train_pred,_,lr_test_pred,_= fit_pred(lr_simple)
```

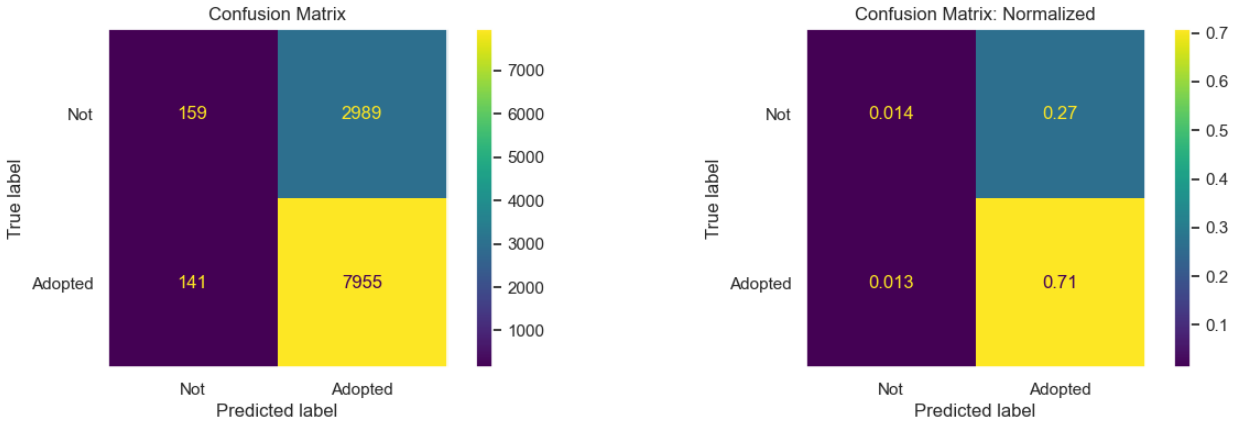
In [57]:
```
#Metrics
calc_metrics(y_train,lr_train_pred)
```

```
The Precision mean score is: 0.73
The Recall mean score is: 0.98
The F1  score is: 0.84
The Accuracy mean score is: 0.72
```

Out[57]:
```
(0.7268823099415205, 0.9825839920948617, 0.835609243697479, 0.721629313411597
3)
```

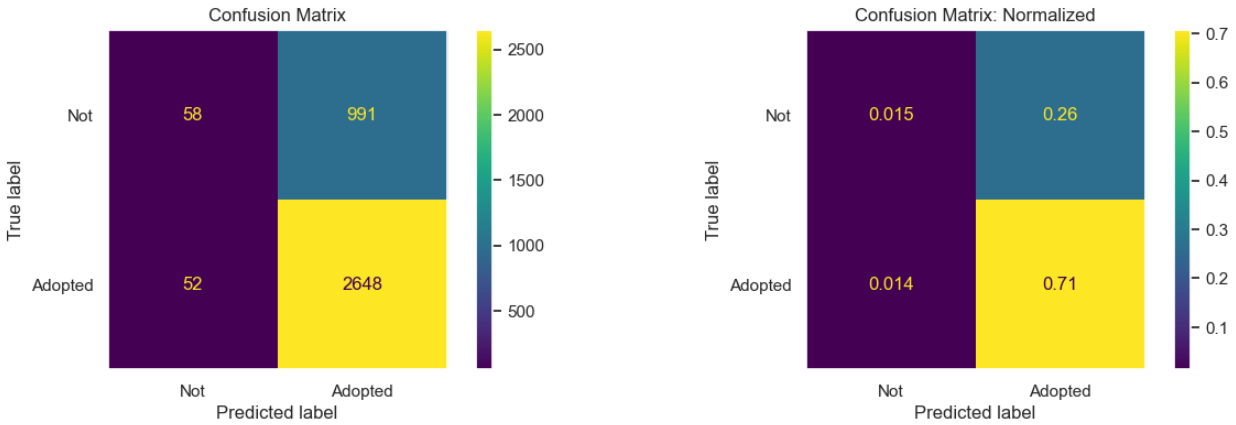
In [58]:
```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,lr_train_pred)
```

```
Train Confusion Matrix:
```



In [59]:
```
print("Test Confusion Matrix:\n")
conf_matrix(y_test,lr_test_pred)
```

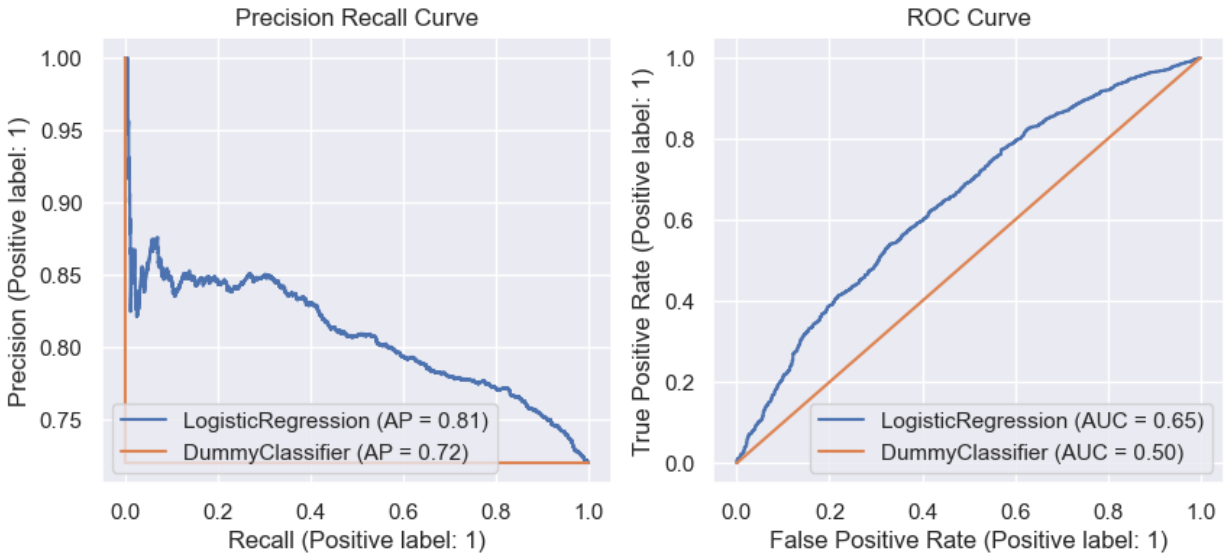
```
Test Confusion Matrix:
```



In [60]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,lr_train_
print("Test Classification Report:\n", classification_report(y_test, lr_test_pr
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.53      0.05      0.09      3148
           1       0.73      0.98      0.84      8096

    accuracy                           0.72     11244
   macro avg       0.63      0.52      0.46     11244
weighted avg       0.67      0.72      0.63     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.53      0.06      0.10      1049
           1       0.73      0.98      0.84      2700

    accuracy                           0.72      3749
   macro avg       0.63      0.52      0.47      3749
weighted avg       0.67      0.72      0.63      3749
```

In [61]:
```
#Print Precision/Recall and AUC Score
plot_curves(lr_simple,X_test,y_test)
```



Model Evaluation

- They both have an average of 26% FP rate from the Confusion Matrix.
- Test and training precision metrics of 73% are very similar.
- The model performs better (81%) than the base Dummy Classifier (~72%)

Baseline KNN

In [62]:
```
#Plotting kNN https://towardsdatascience.com/knn-visualization-in-just-13-lines
```

In [63]:
```
#Scale Data for KNN
#Instantiate StandardScaler
scaler = StandardScaler()
```

```
# Transform the training and test sets
scaled_data_train = scaler.fit_transform(X_train)
scaled_data_test = scaler.transform(X_test)

# Convert into a DataFrame
scaled_df_train = pd.DataFrame(scaled_data_train, columns=X_train.columns)
scaled_df_test = pd.DataFrame(scaled_data_test, columns=X_test.columns)
```

In [64]:
```
#Instantiate
knn_simple = KNeighborsClassifier()
#Fit and Predict
knn_train_pred,_,knn_test_pred,_=fit_pred(knn_simple,scaled_df_train,scaled_df_
```

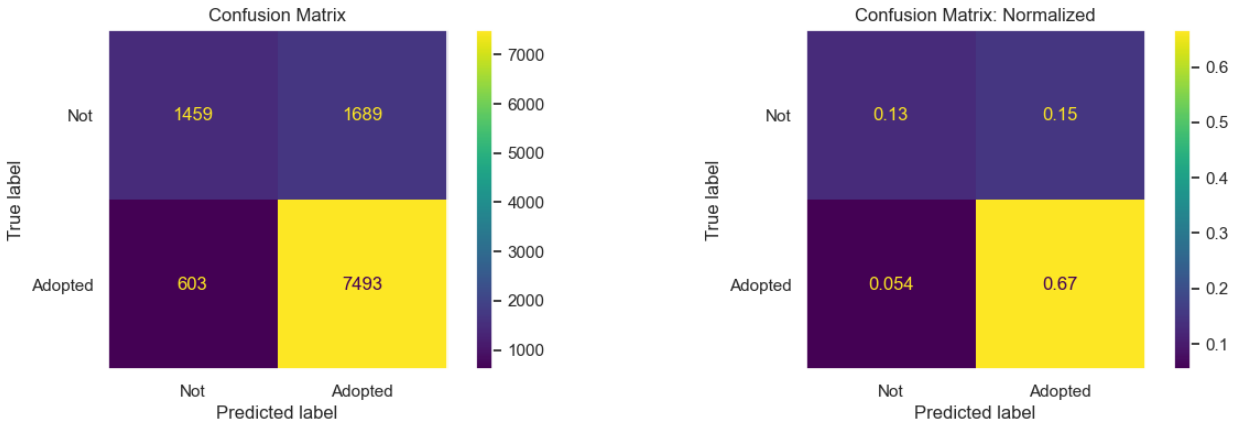
In [65]:
```
#Metrics
print("Train Metrics: ")
calc_metrics(y_train,knn_train_pred)
```

```
Train Metrics:
The Precision mean score is: 0.82
The Recall mean score is: 0.93
The F1  score is: 0.87
The Accuracy mean score is: 0.8
```

Out[65]:
```
(0.8160531474624265,
 0.9255187747035574,
 0.8673457576108345,
 0.7961579509071505)
```

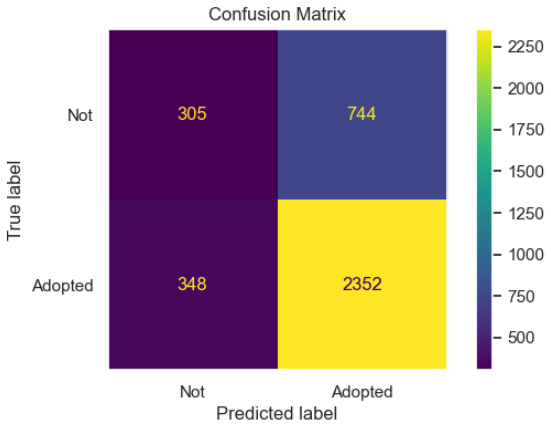
In [66]:
```
#Confusion Matrix
print("Train Confusion Matrices:\n")
conf_matrix(y_train,knn_train_pred)
```

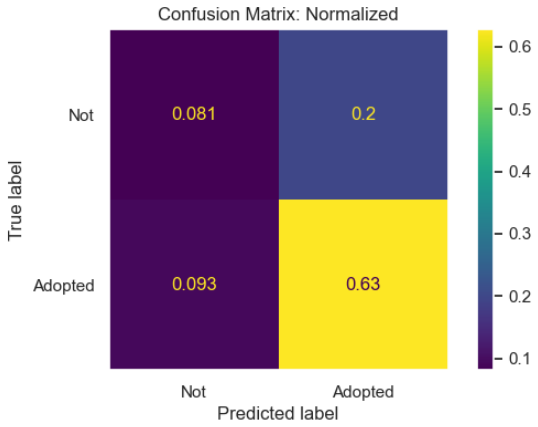
```
Train Confusion Matrices:
```



In [67]:
```
print("Test Confusion Matrices:\n")
conf_matrix(y_test,knn_test_pred)
```

```
Test Confusion Matrices:
```

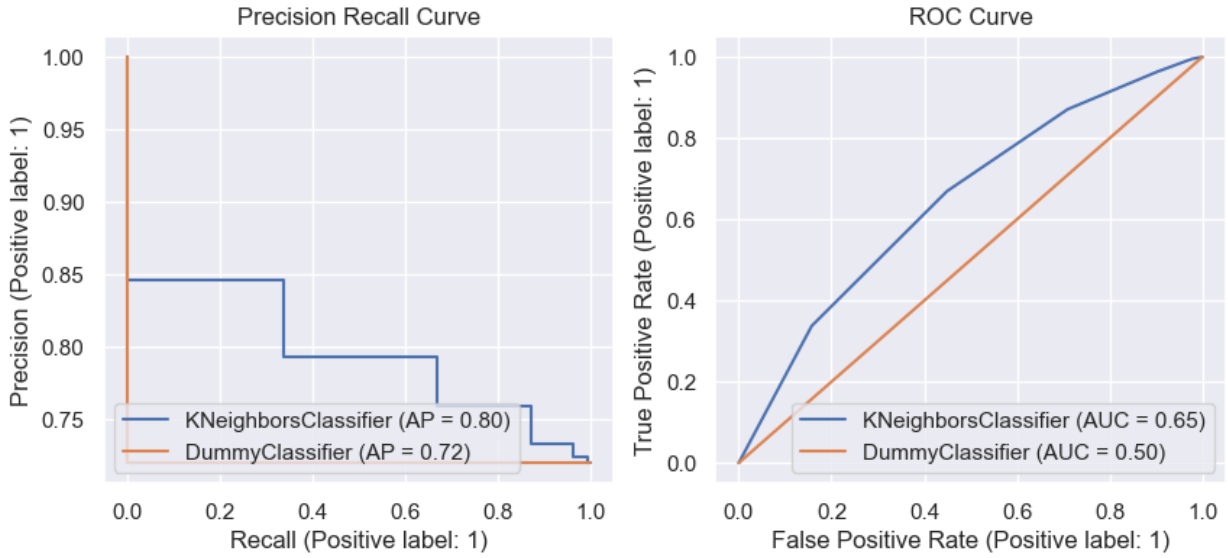




In [68]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,knn_trair
print("Test Classification Report:\n", classification_report(y_test, knn_test_p
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.71      0.46      0.56      3148
           1       0.82      0.93      0.87      8096

    accuracy                           0.80     11244
   macro avg       0.76      0.69      0.71     11244
weighted avg       0.79      0.80      0.78     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.47      0.29      0.36      1049
           1       0.76      0.87      0.81      2700

    accuracy                           0.71      3749
   macro avg       0.61      0.58      0.58      3749
weighted avg       0.68      0.71      0.68      3749
```

In [69]:
```
#Print Precision/Recall and AUC Score
plot_curves(knn_simple,scaled_df_test,y_test)
```



Model Evaluation

- Test 20% FP rate, with training 9% FP rate from the Confusion Matrix.
- Test 76% and training 82% precision metrics. Slowly improving from prior model
- The model performs better (80%) than the base Dummy Classifier (~72%).

Baseline XGBoost

Baseline XGBoost #https://github.com/learn-co-curriculum/dsc-pca-and-pipelines-v2-1/tree/solution

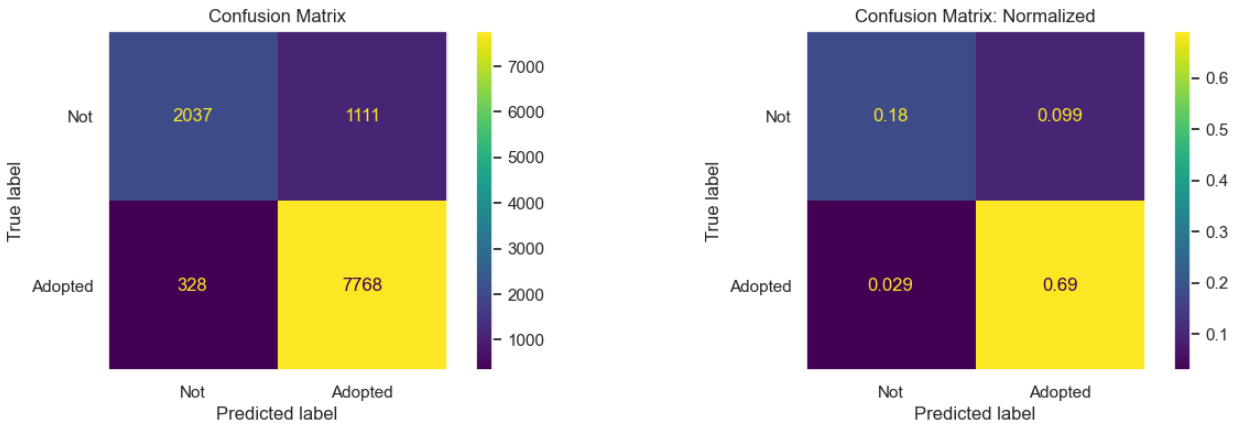
In [70]:
```
#Instantiate
xgb_simple = XGBClassifier(random_state = 42)

#Fit and Predict
xgb_train_pred,_,xgb_test_pred,_= fit_pred(xgb_simple)
```

In [71]:
```
#Metrics
calc_metrics(y_train,xgb_train_pred)
```

```
The Precision mean score is: 0.87
The Recall mean score is: 0.96
The F1  score is: 0.92
The Accuracy mean score is: 0.87
```

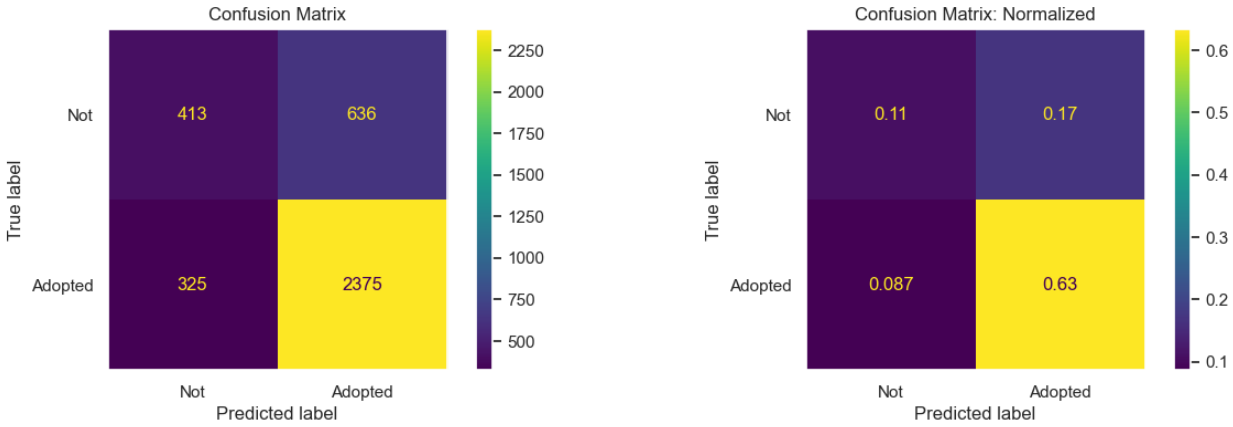
Out[71]:
```
(0.8748732965424034,
 0.9594861660079052,
 0.9152282768777614,
 0.8720206332266097)
```

In [72]:
```
#Confusion Matrix
conf_matrix(y_train,xgb_train_pred)
```



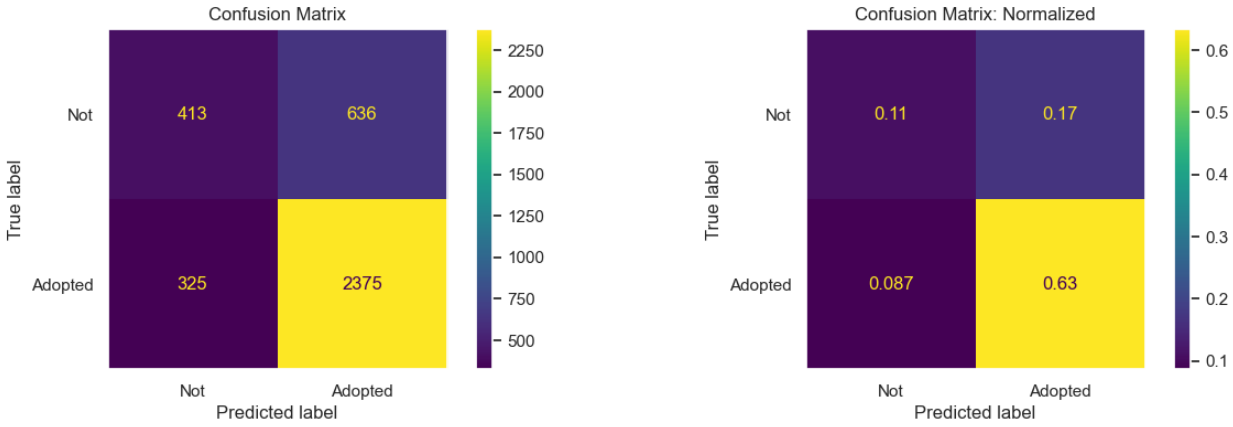
In [73]:
```
#Confusion Matrix
print("Train Confusion Matrices:\n")
conf_matrix(y_test,xgb_test_pred)
```

```
Train Confusion Matrices:
```



In [74]:
```
print("Test Confusion Matrices:\n")
conf_matrix(y_test,xgb_test_pred)
```

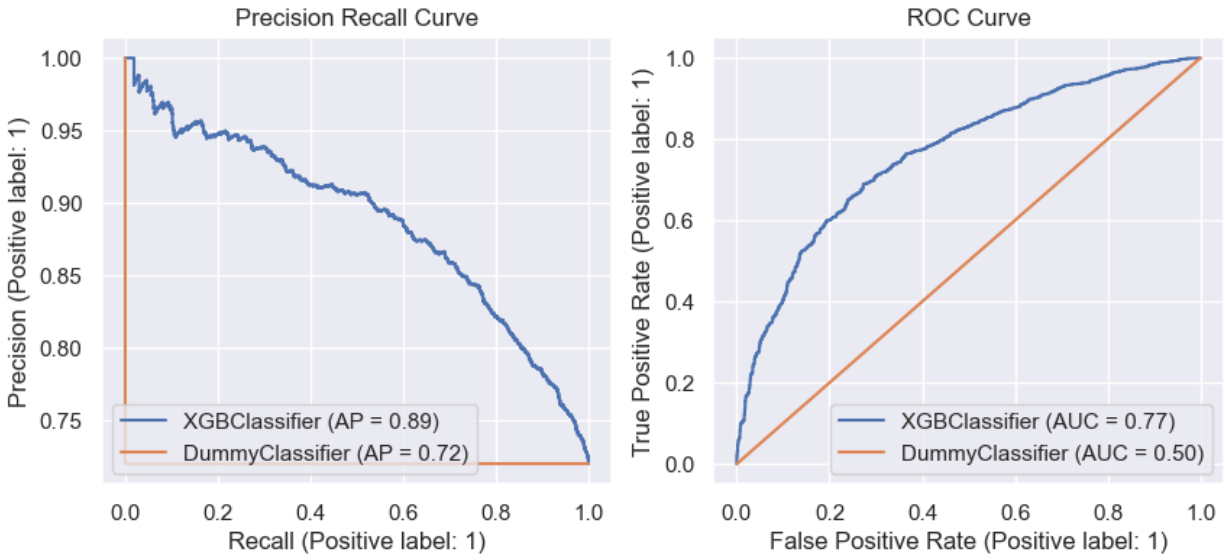
```
Test Confusion Matrices:
```



In [75]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,xgb_trair
print("Test Classification Report:\n", classification_report(y_test, xgb_test_p
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.86      0.65      0.74      3148
           1       0.87      0.96      0.92      8096

    accuracy                           0.87     11244
   macro avg       0.87      0.80      0.83     11244
weighted avg       0.87      0.87      0.87     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.56      0.39      0.46      1049
           1       0.79      0.88      0.83      2700

    accuracy                           0.74      3749
   macro avg       0.67      0.64      0.65      3749
weighted avg       0.72      0.74      0.73      3749
```

In [76]:
```
#Print Precision/Recall and AUC Score
plot_curves(xgb_simple,X_test,y_test)
```



Model Evaluation

- **Test 17% FP rate, with training 10% FP rate from the Confusion Matrix.**
- **Test 79% and training 87% precision metrics.**
- **The model performs better (89%) than the base Dummy Classifier (~72%).**
- **Slowly improving precision and accuracy from prior model.**

Random Forest Baseline

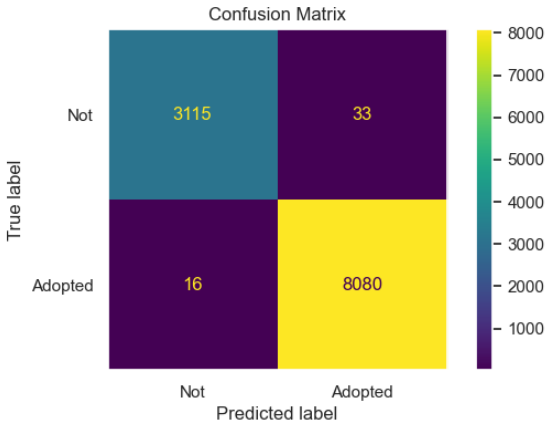
In [77]:
```
#Instantiate
rf_simple = RandomForestClassifier(random_state = 42)

#Fit and Predict
rf_train_pred,_,rf_test_pred,_= fit_pred(rf_simple)
```

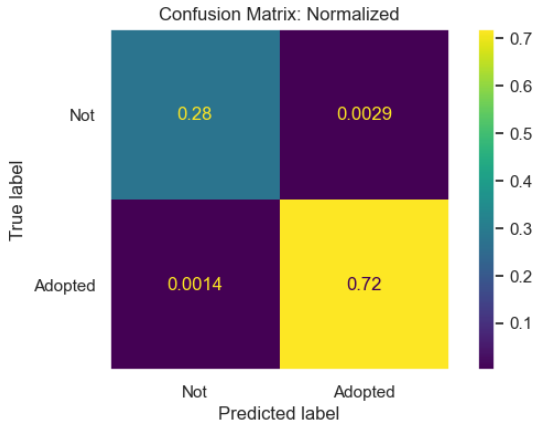
In [78]:
```
#Metrics
calc_metrics(y_test,rf_test_pred)
```

```
The Precision mean score is: 0.79
The Recall mean score is: 0.9
The F1  score is: 0.84
The Accuracy mean score is: 0.75
```

Out[78]:
```
(0.7850919651500484,
 0.9011111111111111,
 0.8391101914123125,
 0.7511336356361696)
```

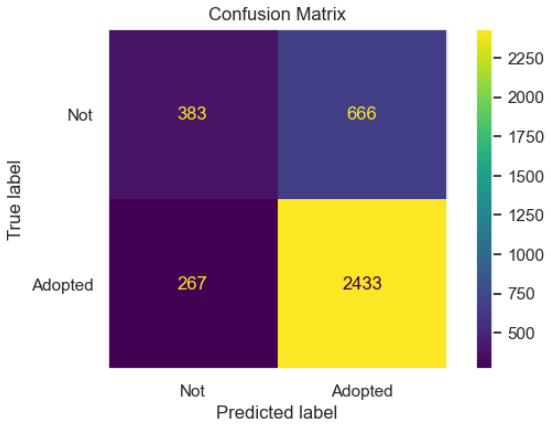
In [79]:
```
#Confusion Matrix
conf_matrix(y_train,rf_train_pred)
```

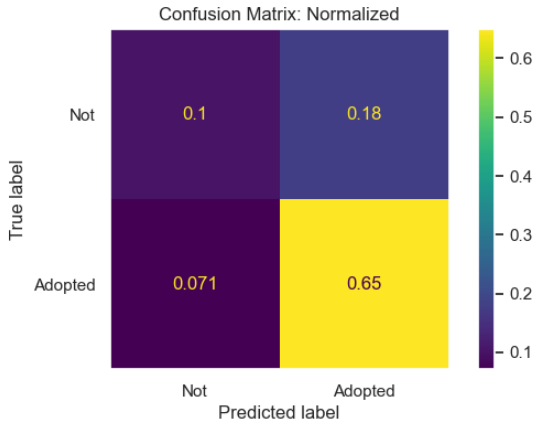




In [80]:
```
print("Test Confusion Matrices:\n")
conf_matrix(y_test,rf_test_pred)
```

```
Test Confusion Matrices:
```

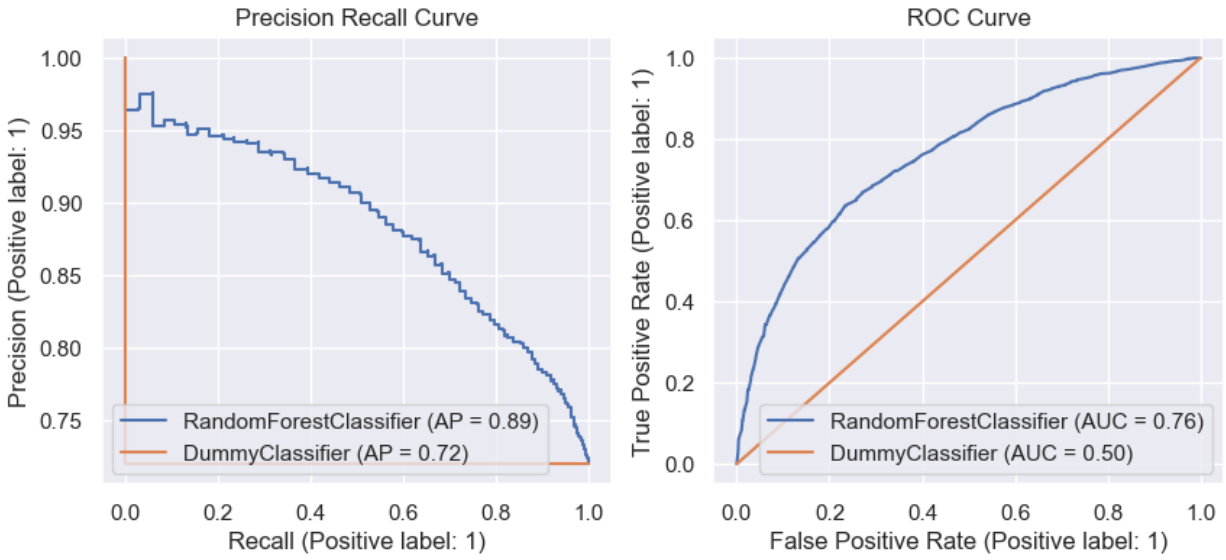




In [81]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,rf_train_
print("Test Classification Report:\n", classification_report(y_test, rf_test_pr
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.99      0.99      0.99      3148
           1       1.00      1.00      1.00      8096

    accuracy                           1.00     11244
   macro avg       1.00      0.99      0.99     11244
weighted avg       1.00      1.00      1.00     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.59      0.37      0.45      1049
           1       0.79      0.90      0.84      2700

    accuracy                           0.75      3749
   macro avg       0.69      0.63      0.64      3749
weighted avg       0.73      0.75      0.73      3749
```

In [82]:
```
#Print Precision/Recall and AUC Score
plot_curves(rf_simple,X_test,y_test)
```



Model Evaluation

- Test 18% FP rate, with training 1% FP rate from the Confusion Matrix.
- Test 79% and training 100% precision metrics.
- The model performs better (89%) than the base Dummy Classifier (~72%).
- Similar but slightly less accurate than the GXBoost model. Training data performs better on the tree algorithms.

Recurrent Neural Net Baseline

In [83]:
```
# Use scaled data from KNN
scaled_df_train.shape
```

Out[83]:
```
(11244, 19)
```

In [84]:
```
nn_model = Sequential([
Dense(5, activation='tanh', input_shape=(19,)),
Dense(1, activation='sigmoid')])
```

```
Metal device set to: Apple M2 Max
2023-04-06 04:12:47.469626: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:12:47.469746: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
```

In [85]:
```
nn_model.compile(loss='binary_crossentropy', optimizer='sgd', metrics=['acc',"F
```

In [86]:
```
nn_results = nn_model.fit(scaled_df_train, y_train, epochs=15, batch_size=250,
```

```
Epoch 1/15
```

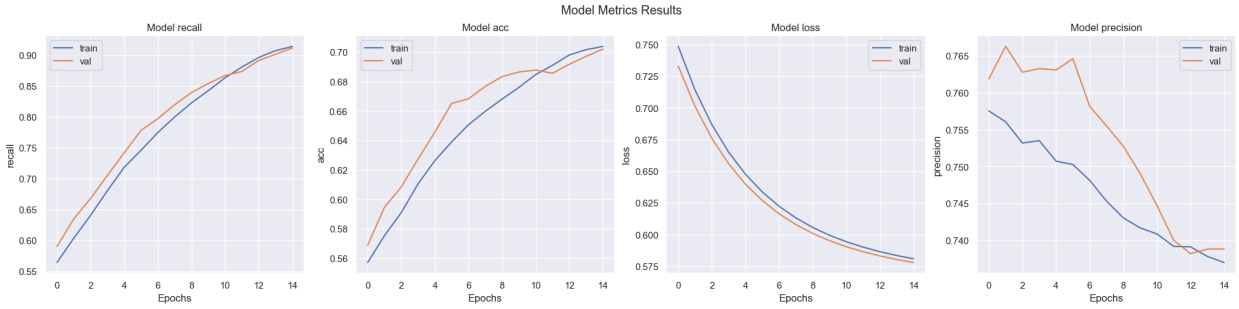
```
2023-04-06 04:12:47.581467: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
 1/36 [..............................] - ETA: 13s - loss: 0.8095 - acc: 0.5080
- recall: 0.5028 - precision: 0.7339
2023-04-06 04:12:47.805716: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
36/36 [==============================] - 1s 17ms/step - loss: 0.7485 - acc: 0.
5570 - recall: 0.5640 - precision: 0.7575 - val_loss: 0.7329 - val_acc: 0.5687
- val_recall: 0.5901 - val_precision: 0.7619
Epoch 2/15
 1/36 [..............................] - ETA: 0s - loss: 0.7600 - acc: 0.5360
- recall: 0.5691 - precision: 0.7305
2023-04-06 04:12:48.400827: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
36/36 [==============================] - 0s 8ms/step - loss: 0.7141 - acc: 0.5
752 - recall: 0.6037 - precision: 0.7561 - val_loss: 0.7012 - val_acc: 0.5945
- val_recall: 0.6348 - val_precision: 0.7663
Epoch 3/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6868 - acc: 0.5
909 - recall: 0.6406 - precision: 0.7532 - val_loss: 0.6760 - val_acc: 0.6083
- val_recall: 0.6679 - val_precision: 0.7628
Epoch 4/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6650 - acc: 0.6
105 - recall: 0.6805 - precision: 0.7535 - val_loss: 0.6559 - val_acc: 0.6274
- val_recall: 0.7053 - val_precision: 0.7633
Epoch 5/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6477 - acc: 0.6
262 - recall: 0.7184 - precision: 0.7507 - val_loss: 0.6398 - val_acc: 0.6456
- val_recall: 0.7420 - val_precision: 0.7631
Epoch 6/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6337 - acc: 0.6
390 - recall: 0.7460 - precision: 0.7503 - val_loss: 0.6269 - val_acc: 0.6652
- val_recall: 0.7782 - val_precision: 0.7646
Epoch 7/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6224 - acc: 0.6
507 - recall: 0.7748 - precision: 0.7481 - val_loss: 0.6164 - val_acc: 0.6683
- val_recall: 0.7972 - val_precision: 0.7582
Epoch 8/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6132 - acc: 0.6
598 - recall: 0.8000 - precision: 0.7453 - val_loss: 0.6079 - val_acc: 0.6767
- val_recall: 0.8199 - val_precision: 0.7555
Epoch 9/15
36/36 [==============================] - 0s 8ms/step - loss: 0.6057 - acc: 0.6
681 - recall: 0.8227 - precision: 0.7430 - val_loss: 0.6010 - val_acc: 0.6834
- val_recall: 0.8395 - val_precision: 0.7527
Epoch 10/15
36/36 [==============================] - 0s 8ms/step - loss: 0.5995 - acc: 0.6
760 - recall: 0.8427 - precision: 0.7417 - val_loss: 0.5952 - val_acc: 0.6865
- val_recall: 0.8542 - val_precision: 0.7491
Epoch 11/15
36/36 [==============================] - 1s 16ms/step - loss: 0.5944 - acc: 0.
6848 - recall: 0.8634 - precision: 0.7409 - val_loss: 0.5905 - val_acc: 0.6879
- val_recall: 0.8670 - val_precision: 0.7447
Epoch 12/15
36/36 [==============================] - 0s 8ms/step - loss: 0.5901 - acc: 0.6
911 - recall: 0.8809 - precision: 0.7392 - val_loss: 0.5865 - val_acc: 0.6856
- val_recall: 0.8738 - val_precision: 0.7400
Epoch 13/15
36/36 [==============================] - 0s 8ms/step - loss: 0.5865 - acc: 0.6
982 - recall: 0.8963 - precision: 0.7391 - val_loss: 0.5832 - val_acc: 0.6919
- val_recall: 0.8915 - val_precision: 0.7382
Epoch 14/15
36/36 [==============================] - 0s 8ms/step - loss: 0.5835 - acc: 0.7
017 - recall: 0.9073 - precision: 0.7378 - val_loss: 0.5804 - val_acc: 0.6972
- val_recall: 0.9013 - val_precision: 0.7388
Epoch 15/15
36/36 [==============================] - 0s 8ms/step - loss: 0.5809 - acc: 0.7
039 - recall: 0.9143 - precision: 0.7370 - val_loss: 0.5780 - val_acc: 0.7021
- val_recall: 0.9118 - val_precision: 0.7388
```

In [87]:
```
#Getting prediction results
nn_train_pred = nn_model.predict(scaled_df_train)
nn_test_pred = nn_model.predict(scaled_df_test)
```

```
141/352 [===========>..................] - ETA: 0s
2023-04-06 04:12:52.946968: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
352/352 [==============================] - 0s 1ms/step
118/118 [==============================] - 0s 1ms/step
```

In [88]:
```
#Plotting Recall, Precision, F1 and Accuracy of Training and Validation
nn_eval_metrics(nn_results)
```



In [89]:
```
#Metrics
calc_metrics(y_train,nn_train_pred)
```

```
The Precision mean score is: 0.74
The Recall mean score is: 0.92
The F1  score is: 0.82
The Accuracy mean score is: 0.71
```

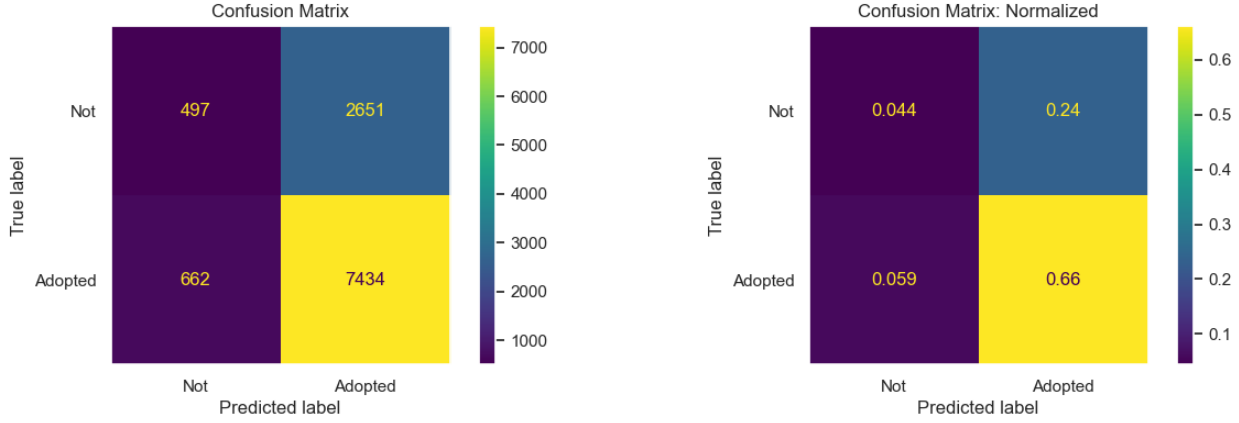
Out[89]:
```
(0.7371343579573624, 0.9182312252964426, 0.817776799955998, 0.705353966559943
1)
```

In [90]:
```
#Metrics
calc_metrics(y_test,nn_test_pred)
```

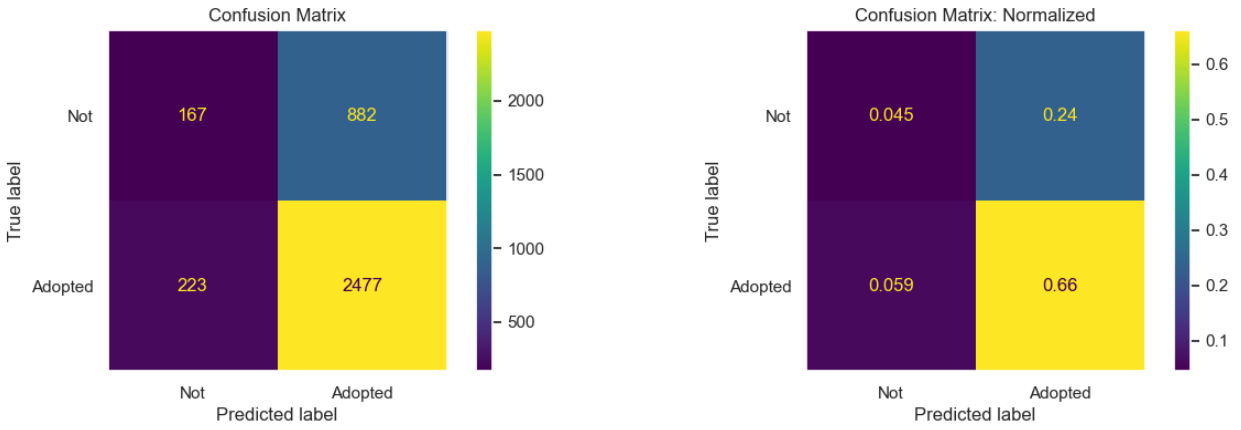
```
The Precision mean score is: 0.74
The Recall mean score is: 0.92
The F1  score is: 0.82
The Accuracy mean score is: 0.71
```

Out[90]:
```
(0.7374218517415898, 0.9174074074074074, 0.817626671067833, 0.705254734595892
3)
```

In [91]:
```
#Confusion Matrix
conf_matrix(y_train,nn_train_pred)
```



In [92]:
```
#Confusion Matrix
conf_matrix(y_test,nn_test_pred)
```



In [93]:
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,np.round(
print("Test Classification Report:\n", classification_report(y_test, np.round(r
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.43      0.16      0.23      3148
           1       0.74      0.92      0.82      8096

    accuracy                           0.71     11244
   macro avg       0.58      0.54      0.52     11244
weighted avg       0.65      0.71      0.65     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.43      0.16      0.23      1049
           1       0.74      0.92      0.82      2700

    accuracy                           0.71      3749
   macro avg       0.58      0.54      0.52      3749
weighted avg       0.65      0.71      0.65      3749
```

Model Evaluation

- Test 27% FP rate, with training 27% FP rate from the Confusion Matrix.
- Test 72% and training 72% precision metrics.
- The test model performs better than the training model.
- The results are better than the KNN and LogRegression but not as good as the tree classifiers. Hypertuning would support this model peforming better than the others.

Model Iteration 2 Hypertuning w/ SMOTE

Creating a scoring dictionary for the gridsearch.

In [94]:
```
#Creation of of scoring dictionary for the gridsearch scoring multimetrics
cus_rec = make_scorer(recall_score)
cus_prec = make_scorer(precision_score)
cus_f1 =  make_scorer(f1_score)
cus_acc =  make_scorer(accuracy_score)
scoring = {"Precision":cus_prec,"Rec": cus_rec,"F1":cus_f1,"Accuracy":cus_acc}
```

Logistic Regression GridsearchCV

- SMOTE Paramters:
  - Sampling Strategy: Wanted to sample to increase the values for the minority class ("Not Adopted"). Chose various values for the hyperparameters that support this.
- Logistic Regression:
  - Logistic Parameters Paramters Chosen:
    - Penalty:[None,"l1",'l2', 'elasticnet']
    - Sovler:["liblinear", "saga","lbfgs"]
- GridSearchCV Parameters:
  - Refit: "Precision"
  - Scoring: [Precision, Recall, Accuracy]
  - n_jobs: The local computer running on 64GB of RAM, it was enough to run multiple jobs in parallel. This is part of the reason multiple hyperparameters and values were chosen.

In [95]:
```
#Create pipelines with Scaling, SMOTE
lr_imb_pipe = ImPipeline(steps=[('ct', StandardScaler()),
                    ('sm', SMOTE( random_state=42)),
                    ("lr", LogisticRegression(random_state=42))])

#fitting the pipeline on the training data
_,_,_,_=fit_pred(lr_imb_pipe)
```

In [96]:
```
#Logistic Regression parameters and GridSearch instantiation
parameters = {"sm__sampling_strategy":["minority",.2,.6],
                      'lr__penalty': [None,"l1",'l2', 'elasticnet'],
                      'lr__solver': ["liblinear", "saga","lbfgs"]}
```

In [97]:
```
#Create pipelines with Scaling, SMOTE
lr_imb_pipe = ImPipeline(steps=[('ct', StandardScaler()),
                    ('sm', SMOTE( random_state=42)),
                    ("lr", LogisticRegression(random_state=42))])
```

In [98]:
```
gs_lr = GridSearchCV(lr_imb_pipe,param_grid=parameters,
                             refit = "Precision",n_jobs=-1,
                              scoring=scoring, return_train_score = True )
start = time.time()
gs_lr.fit(X_train, y_train)
end = time.time()
```

```
print("Sklearn Fit Time:", end - start)
print(gs_lr.best_params_)
```

```
Sklearn Fit Time: 2.2351489067077637
{'lr__penalty': 'l1', 'lr__solver': 'liblinear', 'sm__sampling_strategy': 'min
ority'}
```

In [99]:
```
gs_lr_train_pred,_,gs_lr_test_pred,_=fit_pred(gs_lr.best_estimator_,)
```

Smote value count

Retrieveing the new value counts of y_train when applying SMOTE. These will be the same for all models using gridsearch except the neural net.

In [100…
```
#Getting new value counts of of y_train when using SMOTE to oversample.
X_resample, y_resample = lr_imb_pipe.steps[1][1].fit_resample(X_train,y_train)
```

In [101…
```
#Old Vs New Value Counts
print("Original Value Counts:\n",y_train.value_counts())
print("\n")
print("New Value Counts:\n",y_resample.value_counts())
#Equal
```

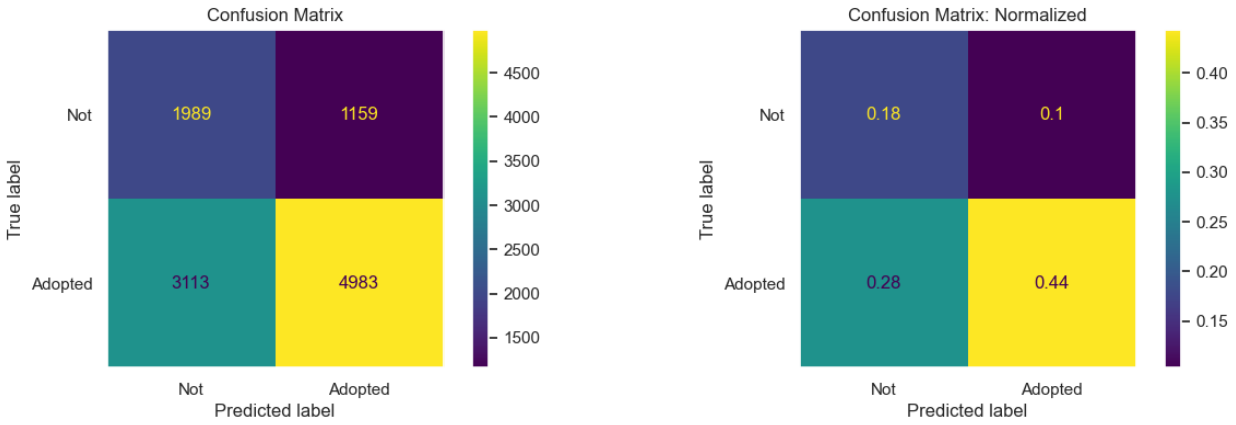
```
Original Value Counts:
 1    8096
0    3148
Name: AdoptionSpeed, dtype: int64


New Value Counts:
 1    8096
0    8096
Name: AdoptionSpeed, dtype: int64
```

In [102…
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,gs_lr_tra
print("Test Classification Report:\n", classification_report(y_test, gs_lr_test
```

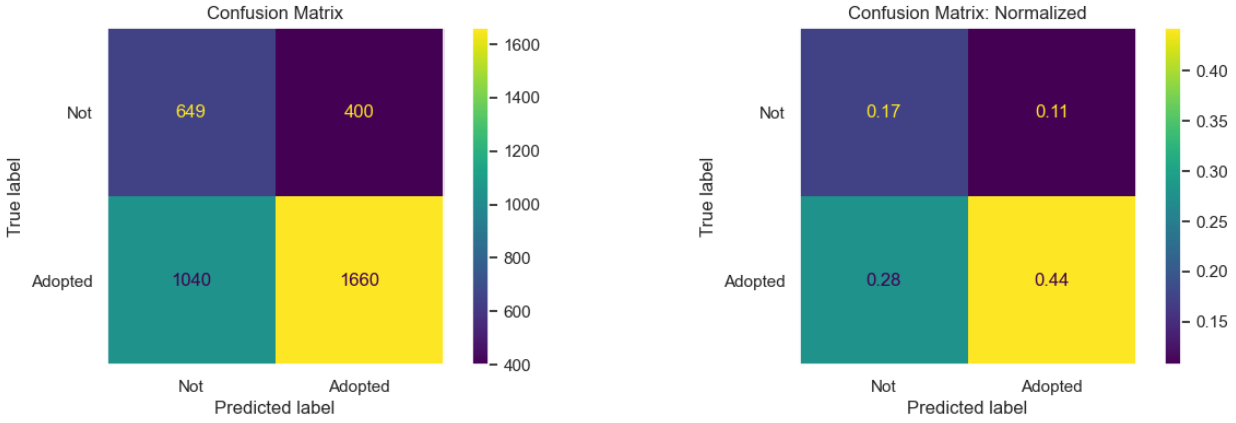
```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.39      0.63      0.48      3148
           1       0.81      0.62      0.70      8096

    accuracy                           0.62     11244
   macro avg       0.60      0.62      0.59     11244
weighted avg       0.69      0.62      0.64     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.38      0.62      0.47      1049
           1       0.81      0.61      0.70      2700

    accuracy                           0.62      3749
   macro avg       0.60      0.62      0.59      3749
weighted avg       0.69      0.62      0.63      3749
```

In [103…
```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,gs_lr_train_pred )
```

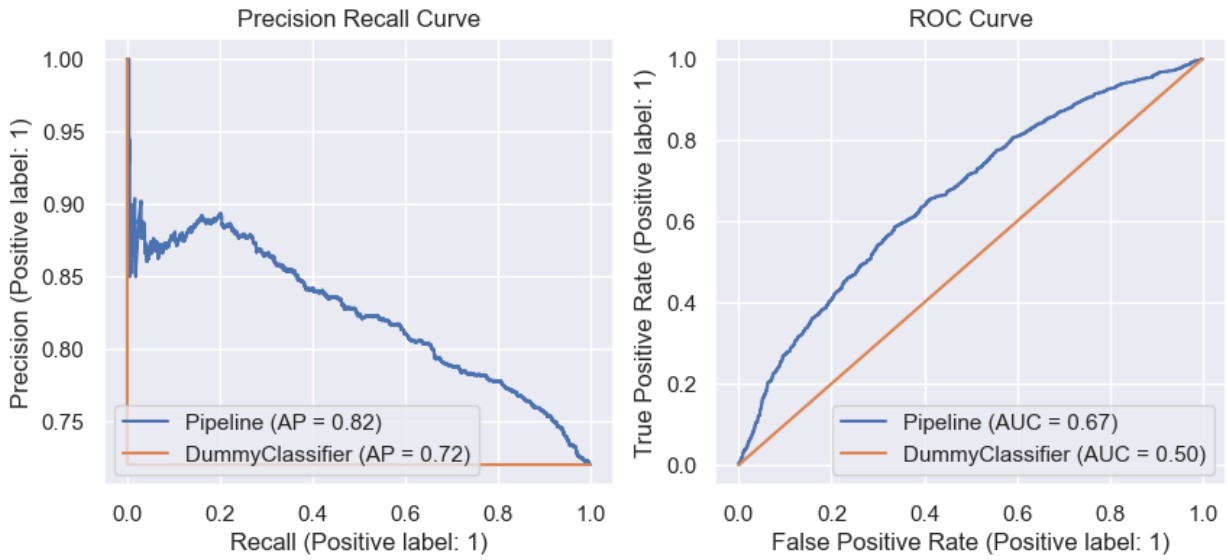
```
Train Confusion Matrix:
```



In [104…
```
#Confusion Matrix
conf_matrix(y_test,gs_lr_test_pred)
```



In [105…
```
#Print Precision/Recall and AUC Score
plot_curves(gs_lr.best_estimator_,X_test,y_test)
```



Model Evaluation

- They both have an average of 11% FP rate from the Confusion Matrix. This is a decreaseD FP from baseline.
- Test and training precision metrics of 73% are very similar.
- The model performs better (82%) than the base Dummy Classifier (~72%)
- One of the bestmodes, based on performance and FP percentage

KNN GridsearchCV

Best KNN Parameters,ARUNIM SAMUDRA,2020

- SMOTE Paramters:
  - Sampling Strategy: Wanted to sample to increase the values for the minority class ("Not Adopted"). Chose various values for the hyperparameters that support this.
- KNN:
  - Hyperparameters Chosen:
    - N-neighbors: [5,10,15]
    - Weights:["uniform", "distance"]
    - Metrics:['minkowski','euclidean']
- GridSearchCV Parameters :
  - Refit: "Precision"
  - Scoring: [Precision, Recall, Accuracy]
  - n_jobs: The local computer running on 64GB of RAM, it was enough to run multiple jobs in parallel. This is part of the reason multiple hyperparameters and values were chosen.

In [106…
```
#Create pipelines with Scaling, SMOTE
knn_imb_pipe = ImPipeline(steps=[('ct', StandardScaler()),
                    ('sm', SMOTE( random_state=42)),
                    ("knn", KNeighborsClassifier())])
```

In [107…
```
#Logistic Regression parameters and GridSearch instantiation
parameters = {"sm__sampling_strategy":["minority",.2,.6],
                     'knn__n_neighbors': [5,10,15],
                     'knn__weights': ["uniform", "distance" ],
                     'knn__metric': ['minkowski','euclidean']}

gs_knn = GridSearchCV(knn_imb_pipe,param_grid=parameters,
                          refit = "Precision",
                           scoring=scoring, return_train_score = True )
```

In [108…
```
start = time.time()
gs_knn.fit(X_train, y_train)
end = time.time()
print("Sklearn Fit Time:", end - start)
print(gs_knn.best_params_)
```

```
Sklearn Fit Time: 22.074202060699463
{'knn__metric': 'minkowski', 'knn__n_neighbors': 10, 'knn__weights': 'unifor
m', 'sm__sampling_strategy': 'minority'}
```

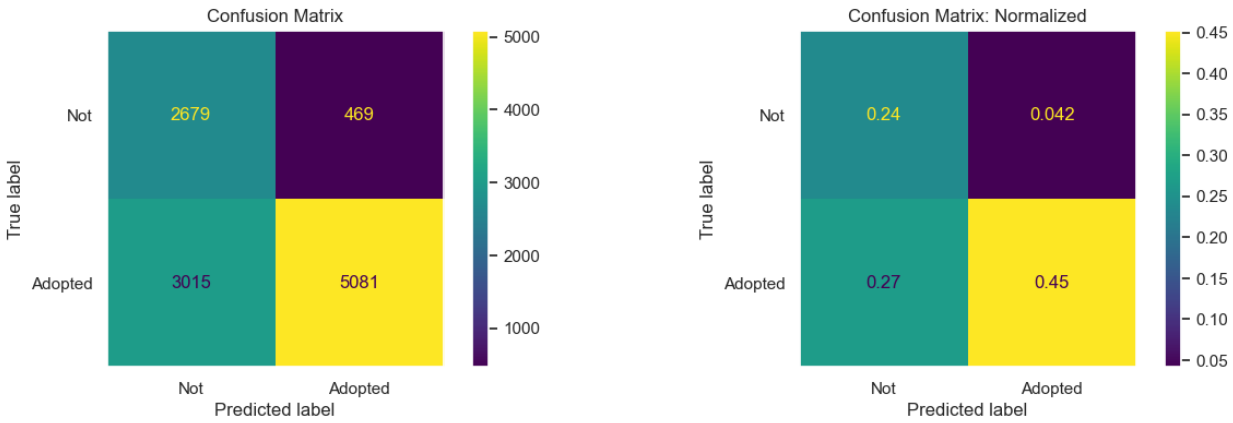
In [109…
```
gs_knn_train_pred,_,gs_knn_test_pred,_=fit_pred(gs_knn.best_estimator_,)
```

In [110…
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,gs_knn_tr
print("Test Classification Report:\n", classification_report(y_test, gs_knn_tes
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.47      0.85      0.61      3148
           1       0.92      0.63      0.74      8096

    accuracy                           0.69     11244
   macro avg       0.69      0.74      0.68     11244
weighted avg       0.79      0.69      0.71     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.37      0.68      0.48      1049
           1       0.82      0.55      0.66      2700

    accuracy                           0.59      3749
   macro avg       0.60      0.62      0.57      3749
weighted avg       0.69      0.59      0.61      3749
```

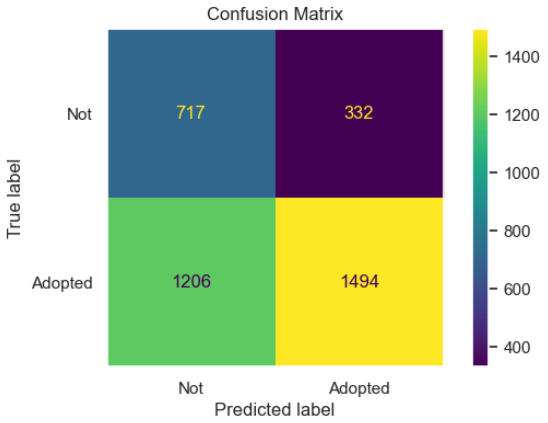
In [111…
```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,gs_knn_train_pred )
```

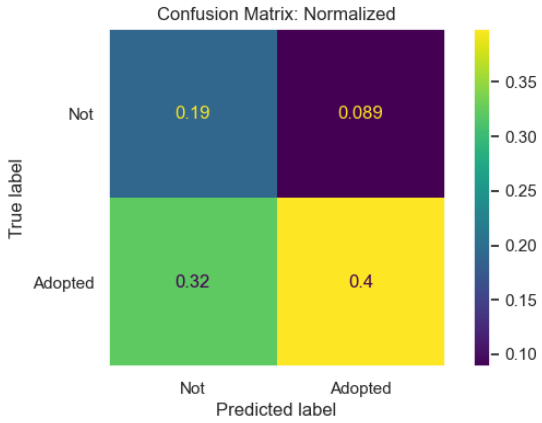
```
Train Confusion Matrix:
```



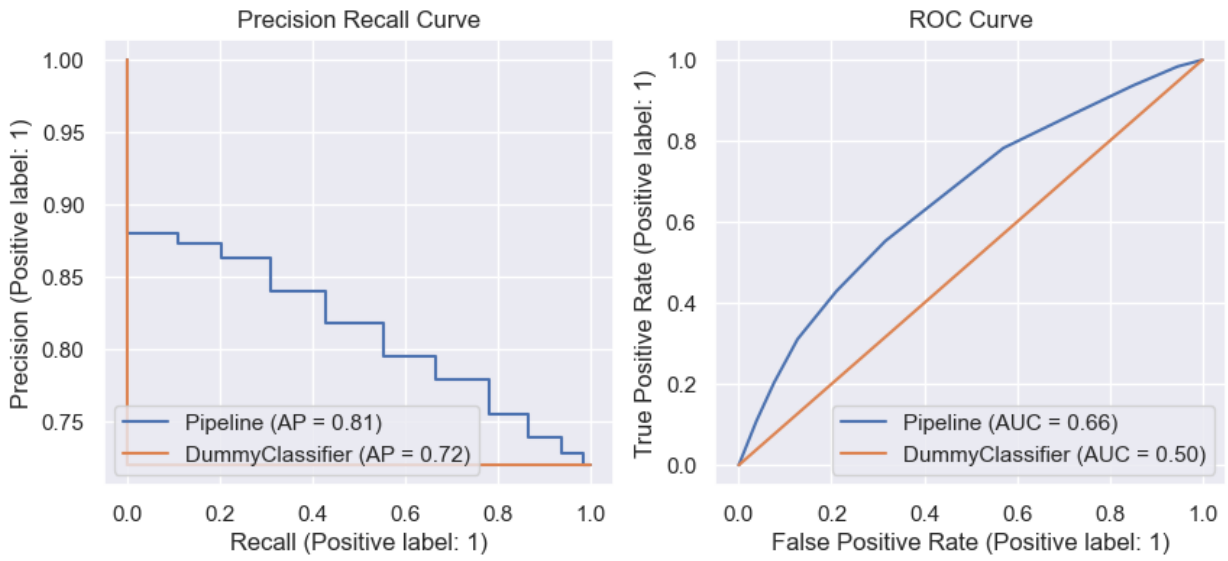
In [112…
```
#Confusion Matrix
print("Test Confusion Matrix:\n")
conf_matrix(y_test,gs_knn_test_pred)
```

```
Test Confusion Matrix:
```





In [113…
```
#Print Precision/Recall and AUC Curve
plot_curves(gs_knn.best_estimator_,X_test,y_test)
```



Model Evaluation

- **They both have an average of 11% FP rate from the Confusion Matrix. This is a decrease FP from baseline.**
- **Test and training precision metrics of 73% are very similar.**
- **The model performs better (82%) than the base Dummy Classifier (~72%)**

XGBoost GridsearchCV

XGBoost Hyp, Mahbubul Alam,2021

- **SMOTE Paramters:**
  - **Sampling Strategy: Wanted to sample to increase the values for the minority class ("Not Adopted"). Chose various values for the hyperparameters that support this.**
- **XGBoost:**
  - **Hyperparameters Chosen:**

    - N-estimators: [20,40,120]
    - Max_depth:[6,9,12,]
    - Learning_rate:[.01,.1,]
    - Gamma:[3,5,6]
- GridSearchCV Parameters :
  - Refit: "Precision"
  - Scoring: [Precision, Recall, Accuracy]
  - n_jobs: The local computer running on 64GB of RAM, it was enough to run multiple jobs in parallel. This is part of the reason multiple hyperparameters and values were chosen.

In [114…
```
#Create pipelines with Scaling, SMOTE
xgb_imb_pipe = ImPipeline(steps=[('ct', StandardScaler()),
                    ('sm', SMOTE( random_state=42)),
                    ("xgb", XGBClassifier(random_state=42))])
```

In [115…
```
#Logistic Regression parameters and GridSearch instantiation
parameters = {"sm__sampling_strategy":["minority",.2],
                      'xgb__n_estimators': [20,40,120],
                      'xgb__max_depth': [6,9,12,],
                      'xgb__learning_rate': [.01,.1,],
                      'xgb__gamma': [3,5,6]}

gs_xgb = GridSearchCV(xgb_imb_pipe,param_grid=parameters,
                            refit = "Precision",n_jobs=-1,
                             scoring=scoring, return_train_score = True )
```

In [116…
```
start = time.time()
gs_xgb.fit(X_train, y_train)
end = time.time()
print("Sklearn Fit Time:", end - start)
print(gs_xgb.best_params_)
```

```
Sklearn Fit Time: 38.52939009666443
{'sm__sampling_strategy': 'minority', 'xgb__gamma': 3, 'xgb__learning_rate':
0.01, 'xgb__max_depth': 6, 'xgb__n_estimators': 120}
```

In [117…
```
gs_xgb_train_pred,_,gs_xgb_test_pred,_=fit_pred(gs_xgb.best_estimator_,)
```

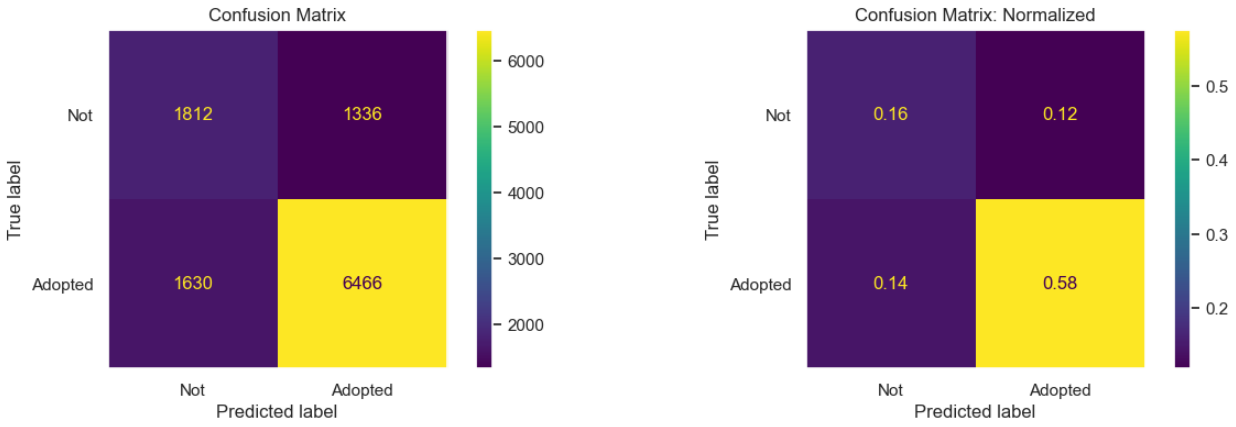
In [118…
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,gs_xgb_tr
print("Test Classification Report:\n", classification_report(y_test, gs_xgb_tes
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.53      0.58      0.55      3148
           1       0.83      0.80      0.81      8096

    accuracy                           0.74     11244
   macro avg       0.68      0.69      0.68     11244
weighted avg       0.74      0.74      0.74     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.49      0.53      0.51      1049
           1       0.81      0.78      0.80      2700

    accuracy                           0.71      3749
   macro avg       0.65      0.66      0.65      3749
weighted avg       0.72      0.71      0.72      3749
```

In [119…

```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,gs_xgb_train_pred )
```

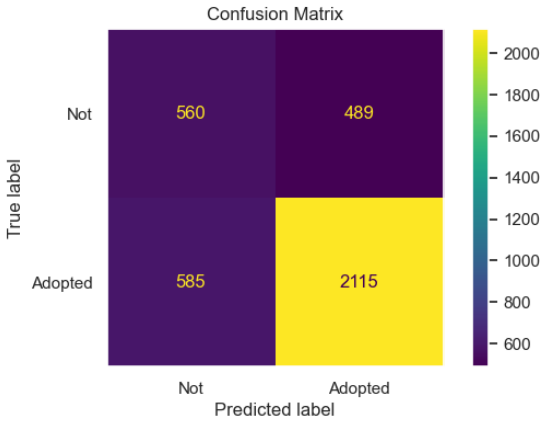
```
Train Confusion Matrix:
```

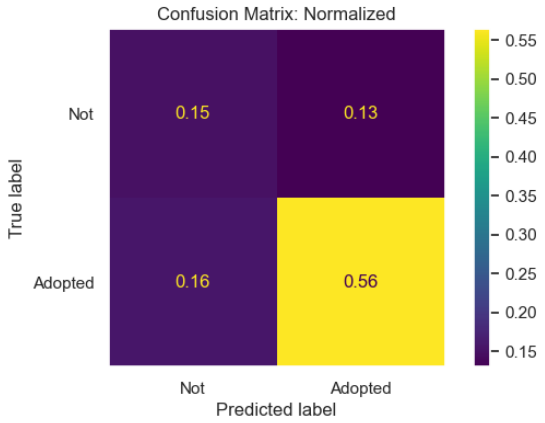


In [120…

```
#Confusion Matrix
print("Test Confusion Matrix:\n")
conf_matrix(y_test,gs_xgb_test_pred)
```

```
Test Confusion Matrix:
```





In [121…
```
#Print Precision/Recall and AUC Curve
plot_curves(gs_xgb.best_estimator_,X_test,y_test)
```

Model Evaluation

- **They both have an average of ~12% FP rate from the Confusion Matrix. This is a decreased FP from baseline.**
- **Test and training precision metrics of ~81% and 82% respectively**
- **The model performs better (87%) than the base Dummy Classifier (~72%)**
- **The best modeol based on performance and FP and FN percentage**

Random Forest GridsearchCV

- **SMOTE Paramters:**
  - **Sampling Strategy: Wanted to sample to increase the values for the minority class ("Not Adopted"). Chose various values for the hyperparameters that support this.**
- **Random Forest:**
  - **Logistic Parameters Paramters Chosen:**
    - **N-estimators: [5,10,25,50]**

    - Criterion:["gini", "entropy"]
    - Max_depth:[None, 5,15,25]
    - Min_sample_leaf:[5,7]
- GridSearchCV Parameters :
    - Refit: "Precision"
    - Scoring: [Precision, Recall, Accuracy]
    - n_jobs: The local computer running on 64GB of RAM, it was enough to run multiple jobs in parallel. This is part of the reason multiple hyperparameters and values were chosen.

In [122…
```
#Create pipelines with Scaling, SMOTE
rf_imb_pipe = ImPipeline(steps=[('ct', StandardScaler()),
                    ('sm', SMOTE( random_state=42)),
                    ("rf", RandomForestClassifier(random_state=42))])
```

In [123…
```
#Random Forest parameters and GridSearch instantiation
parameters = {"sm__sampling_strategy":["minority",.2,.6],
                      'rf__n_estimators': [5,10,25,50],
                      'rf__criterion': ["gini", "entropy"],
                      'rf__max_depth': [None, 5,15,25],
                      'rf__min_samples_leaf': [5,7]}


gs_rf = GridSearchCV(rf_imb_pipe,param_grid=parameters,
                           refit = "Precision",n_jobs=-1,
                            scoring=scoring, return_train_score = True )
```

In [124…
```
start = time.time()
gs_rf.fit(X_train, y_train)
end = time.time()
print(" Fit Time:", end - start)
print(gs_rf.best_params_)
```

```
 Fit Time: 13.532716751098633
{'rf__criterion': 'gini', 'rf__max_depth': 5, 'rf__min_samples_leaf': 5, 'rf__
n_estimators': 10, 'sm__sampling_strategy': 'minority'}
```

In [125…
```
gs_rf_train_pred,_,gs_rf_test_pred,_=fit_pred(gs_rf.best_estimator_)
```

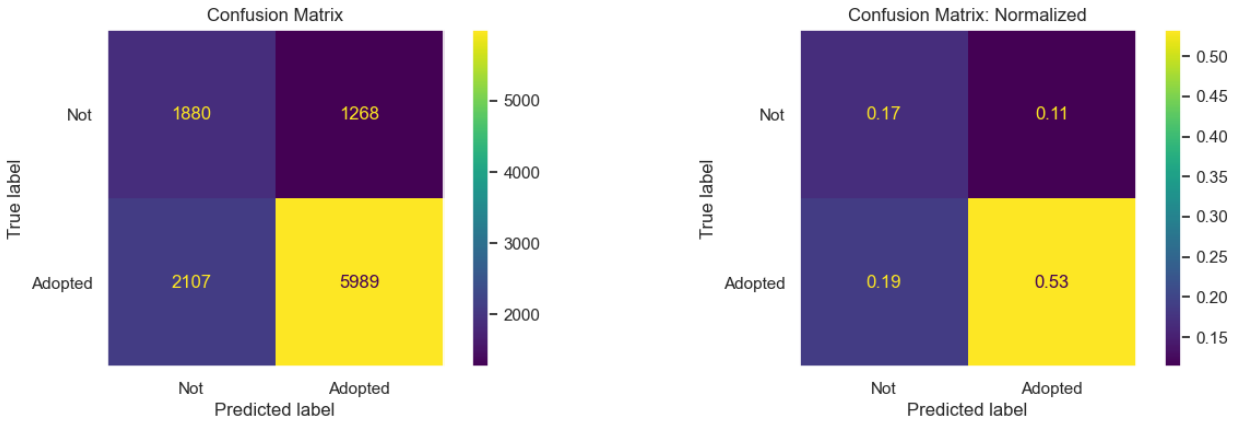
In [126…
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,gs_rf_tra
print("Test Classification Report:\n", classification_report(y_test, gs_rf_test
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.47      0.60      0.53      3148
           1       0.83      0.74      0.78      8096

    accuracy                           0.70     11244
   macro avg       0.65      0.67      0.65     11244
weighted avg       0.73      0.70      0.71     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.46      0.59      0.51      1049
           1       0.82      0.73      0.77      2700

    accuracy                           0.69      3749
   macro avg       0.64      0.66      0.64      3749
weighted avg       0.72      0.69      0.70      3749
```

In [127…

```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,gs_rf_train_pred )
```

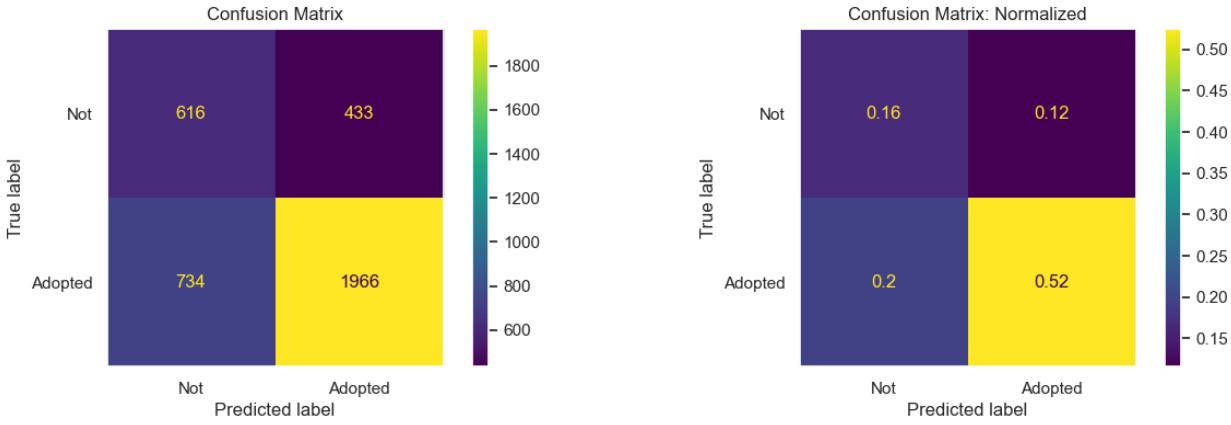
```
Train Confusion Matrix:
```



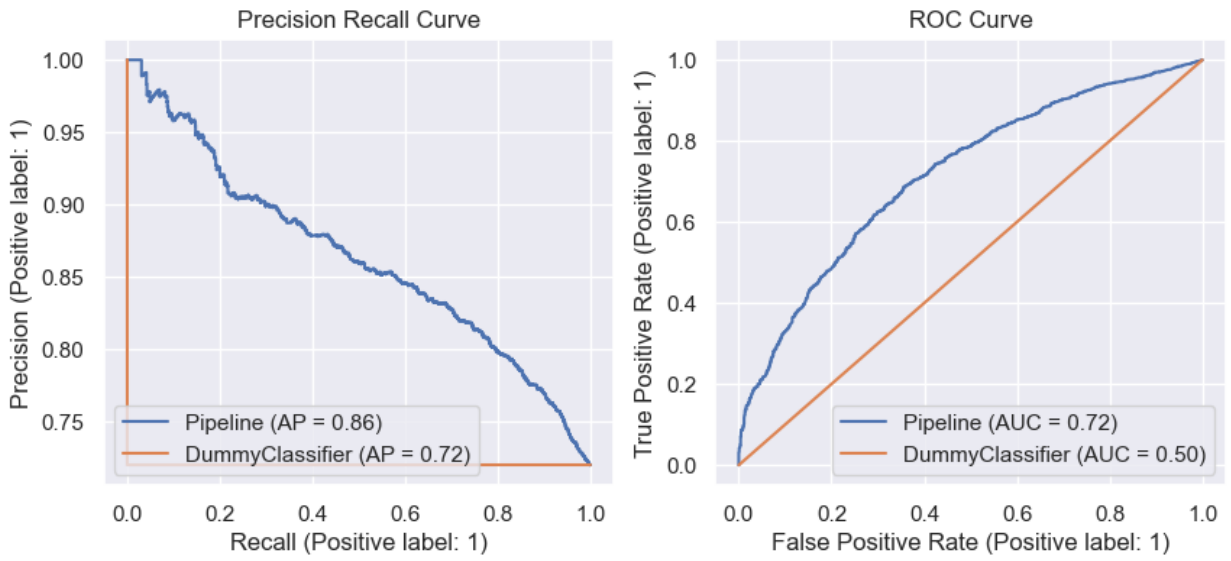
In [128…

```
#Confusion Matrix
print("Test Confusion Matrix:\n")
conf_matrix(y_test,gs_rf_test_pred)
```

```
Test Confusion Matrix:
```



In [129…
```
#Print Precision/Recall and AUC Curve
plot_curves(gs_rf.best_estimator_,X_test,y_test)
```



Model Evaluation

- **They both have an average of ~12% FP rate from the Confusion Matrix. This is a decrease FP from baseline.**
- **Test and training precision metrics of ~82% and 83% respectively**
- **The model performs better (75%) than the base Dummy Classifier (~72%)**
- **The baseline Random Forest model performs better. This is only a little better than the Dummy Classifier.**

Neural Net GridsearchCV

Gridsearch Keras, Jason Brownlee, 2022
Gridsearch NN,AARYN DHOR, 2020
Hyperparamters, Rukshan Pramoditha, 2022

- **SMOTE Parameters: No SMOTE was used here. Class_Weight:{1: 0.6944169960474308, 0: 1.7858958068614994}**

- Neural Net:
  - Layers:
    - Dense Layer (10)
      - Activation: "tanh"
    - Dense Layer (10)
      - Activation: "relu"
    - Dense Layer (10)
      - Activation: "sigmoid"
  - Hyperparamters Chosen:
    - Dropout_rate: [.3,.5]
    - learning_rate: [.0001,.001]
    - Epoch: [None, 5,15,25]
    - BatchSize:[5,7]
    - Optimizer: SGD
    - Loss: Binary Cross Entropy
    - Metrics: ["acc","Recall","Precision"]
- GridSearchCV Parameters :
  - Refit: "Acc"
  - Scoring: "Accuracy"
  - n_jobs: The local computer running on 64GB of RAM, it was enough to run multiple jobs in parallel. This is part of the reason multiple hyperparameters and values were chosen.

In [130…
```
def buildModel(dropout_rate,learning_rate):
    model = models.Sequential(
        [
    Dense(10, activation='tanh',input_shape=(19,)),
    Dropout(dropout_rate),
    Dense(10, activation='relu'),
    Dropout(dropout_rate),
    Dense(1, activation='sigmoid')
        ]
    )

    model.compile(loss='binary_crossentropy',
                  optimizer= SGD(learning_rate = learning_rate),
                  metrics=["acc","Recall","Precision"]
                   )
    return model
```

In [131…
```
#Hyperparameters for GridsearchCV
dropout_rate = [.3,.5]
learning_rate = [.0001,.001]

#Creating a dictionary to use as parameters
parameters = dict(dropout_rate=dropout_rate , learning_rate=learning_rate )
parameters
```

Out[131]:
```
{'dropout_rate': [0.3, 0.5], 'learning_rate': [0.0001, 0.001]}
```

In [132…
```
classes = [1,0]
weights = compute_class_weight(class_weight='balanced', classes=classes,  y=y_t
class_weights = dict(zip(classes, weights))
class_weights
```

Out[132]:
```
{1: 0.6944169960474308, 0: 1.7858958068614994}
```

In [133…
```
#Creating a wrapped classifier
classifier = KerasClassifier(build_fn=buildModel, class_weight = class_weights,

#Gridsearch Creation
gs_nn = GridSearchCV(estimator = classifier,
                           param_grid = parameters,
                           refit = "Acc",
                           scoring = "accuracy",n_jobs=-1,

                     cv = 3,return_train_score=True)
#Gridsearch Fitting
start = time.time()
gs_nn.fit(scaled_data_train, y_train,)
end = time.time()
print("Gridsearch Fit Time:", end - start)
print(gs_nn.best_params_)
```

```
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
```

```
2023-04-06 04:14:17.808585: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:17.808711: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:17.833844: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:17.833999: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:17.876200: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:17.876349: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:17.877194: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:17.877324: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.016080: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.089442: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.155640: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.155791: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.163876: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.164341: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.170022: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.180951: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.193143: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.193282: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.216082: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
```

```
2023-04-06 04:14:18.216227: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
Epoch 1/45
Epoch 1/45
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Epoch 1/45
Epoch 1/45
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Metal device set to: Apple M2 Max
Epoch 1/45
Epoch 1/45
2023-04-06 04:14:18.257718: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.257851: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.284339: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.284477: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.299572: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.299687: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.309975: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-04-06 04:14:18.310120: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
2023-04-06 04:14:18.375718: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.385301: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.396161: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.433851: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.452245: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
Epoch 1/45
Epoch 1/45
Epoch 1/45
Epoch 1/45
```

```
2023-04-06 04:14:18.498730: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.532776: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.534871: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.608876: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.643677: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.656808: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
2023-04-06 04:14:18.681267: W tensorflow/core/platform/profile_utils/cpu_util
s.cc:128] Failed to get CPU frequency: 0 Hz
```

```
Epoch 1/45
Epoch 1/45
 1/75 [..............................] - ETA: 50s - loss: 1.0791 - acc: 0.4800
- recall: 0.5588 - precision: 0.6333
```

```
2023-04-06 04:14:18.753975: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.835335: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
15/75 [=====>........................] - ETA: 1s - loss: 0.8188 - acc: 0.5440
- recall: 0.6053 - precision: 0.7093
```

```
2023-04-06 04:14:18.980710: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:18.988312: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:19.051589: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:19.139526: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:19.157077: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:14:19.165218: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
75/75 [==============================] - 2s 22ms/step - loss: 0.8249 - acc: 0.
5680 - recall: 0.6492 - precision: 0.7231
Epoch 2/45
75/75 [==============================] - 3s 24ms/step - loss: 0.8294 - acc: 0.
5366 - recall: 0.5954 - precision: 0.7108
Epoch 2/45
75/75 [==============================] - 2s 23ms/step - loss: 0.9639 - acc: 0.
5292 - recall: 0.5713 - precision: 0.7178
53/75 [====================>.........] - ETA: 0s - loss: 0.8333 - acc: 0.5721
- recall: 0.6441 - precision: 0.7280Epoch 2/45
75/75 [==============================] - 3s 25ms/step - loss: 1.0865 - acc: 0.
4907 - recall: 0.5316 - precision: 0.6868
Epoch 2/45
75/75 [==============================] - 3s 37ms/step - loss: 0.8264 - acc: 0.
5776 - recall: 0.6568 - precision: 0.7316
Epoch 2/45
75/75 [==============================] - 3s 35ms/step - loss: 0.8275 - acc: 0.
5735 - recall: 0.6477 - precision: 0.7272
Epoch 2/45
75/75 [==============================] - 4s 35ms/step - loss: 0.9340 - acc: 0.
5511 - recall: 0.5983 - precision: 0.7318
Epoch 2/45
75/75 [==============================] - 3s 34ms/step - loss: 0.9398 - acc: 0.
5332 - recall: 0.5574 - precision: 0.7310
Epoch 2/45
75/75 [==============================] - 2s 24ms/step - loss: 0.8229 - acc: 0.
5775 - recall: 0.6598 - precision: 0.7284
60/75 [========================>.....] - ETA: 0s - loss: 1.0197 - acc: 0.5500
- recall: 0.5982 - precision: 0.7252Epoch 3/45
75/75 [==============================] - 2s 23ms/step - loss: 0.8165 - acc: 0.
5303 - recall: 0.5792 - precision: 0.7116
Epoch 3/45
75/75 [==============================] - 4s 32ms/step - loss: 0.8188 - acc: 0.
5484 - recall: 0.5961 - precision: 0.7298
Epoch 2/45
75/75 [==============================] - 2s 24ms/step - loss: 0.9812 - acc: 0.
5181 - recall: 0.5639 - precision: 0.7080
28/75 [==========>...................] - ETA: 0s - loss: 0.8453 - acc: 0.5807
- recall: 0.6603 - precision: 0.7245Epoch 3/45
75/75 [==============================] - 4s 29ms/step - loss: 0.8255 - acc: 0.
5639 - recall: 0.6324 - precision: 0.7270
Epoch 2/45
75/75 [==============================] - 2s 25ms/step - loss: 1.0733 - acc: 0.
4951 - recall: 0.5355 - precision: 0.6904
26/75 [=========>....................] - ETA: 1s - loss: 0.9297 - acc: 0.5200
- recall: 0.5393 - precision: 0.7323Epoch 3/45
75/75 [==============================] - 4s 32ms/step - loss: 0.9391 - acc: 0.
5216 - recall: 0.5697 - precision: 0.7111
29/75 [==========>...................] - ETA: 1s - loss: 0.9126 - acc: 0.5262
- recall: 0.5447 - precision: 0.7364Epoch 2/45
75/75 [==============================] - 4s 33ms/step - loss: 1.0133 - acc: 0.
5480 - recall: 0.5962 - precision: 0.7243
Epoch 2/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8224 - acc: 0.
5802 - recall: 0.6564 - precision: 0.7346
Epoch 3/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8237 - acc: 0.
5744 - recall: 0.6492 - precision: 0.7275
Epoch 3/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9590 - acc: 0.
```

```
5479 - recall: 0.5992 - precision: 0.7274
55/75 [=====================>.......] - ETA: 0s - loss: 0.9941 - acc: 0.5165
- recall: 0.5596 - precision: 0.7040Epoch 3/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9119 - acc: 0.
5279 - recall: 0.5507 - precision: 0.7279
Epoch 3/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8167 - acc: 0.
5658 - recall: 0.6499 - precision: 0.7202
61/75 [=======================>......] - ETA: 0s - loss: 0.9884 - acc: 0.5187
- recall: 0.5612 - precision: 0.7086Epoch 4/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8005 - acc: 0.
5470 - recall: 0.5901 - precision: 0.7313
59/75 [======================>.......] - ETA: 0s - loss: 1.0195 - acc: 0.4846
- recall: 0.5156 - precision: 0.6870Epoch 3/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9882 - acc: 0.
5173 - recall: 0.5611 - precision: 0.7085
Epoch 4/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8057 - acc: 0.
5695 - recall: 0.6390 - precision: 0.7300
Epoch 3/45
75/75 [==============================] - 2s 30ms/step - loss: 1.0143 - acc: 0.
4915 - recall: 0.5217 - precision: 0.6927
Epoch 4/45
75/75 [==============================] - 3s 36ms/step - loss: 0.8182 - acc: 0.
5312 - recall: 0.5829 - precision: 0.7108
15/75 [=====>........................] - ETA: 2s - loss: 0.7668 - acc: 0.5560
- recall: 0.5925 - precision: 0.7595Epoch 4/45
75/75 [==============================] - 2s 32ms/step - loss: 0.9383 - acc: 0.
5105 - recall: 0.5523 - precision: 0.7066
Epoch 3/45
75/75 [==============================] - 2s 30ms/step - loss: 1.0248 - acc: 0.
5415 - recall: 0.5837 - precision: 0.7230
23/75 [========>.....................] - ETA: 1s - loss: 0.8099 - acc: 0.5574
- recall: 0.6266 - precision: 0.7266Epoch 3/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8093 - acc: 0.
5810 - recall: 0.6653 - precision: 0.7294
47/75 [=================>............] - ETA: 0s - loss: 0.8186 - acc: 0.5268
- recall: 0.5722 - precision: 0.7079Epoch 5/45
75/75 [==============================] - 3s 34ms/step - loss: 0.8275 - acc: 0.
5752 - recall: 0.6501 - precision: 0.7323
Epoch 4/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8279 - acc: 0.
5646 - recall: 0.6384 - precision: 0.7217
Epoch 4/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9430 - acc: 0.
5506 - recall: 0.5957 - precision: 0.7326
66/75 [=========================>....] - ETA: 0s - loss: 0.9103 - acc: 0.5282
- recall: 0.5506 - precision: 0.7289Epoch 4/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9051 - acc: 0.
5307 - recall: 0.5542 - precision: 0.7295
Epoch 4/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9661 - acc: 0.
5253 - recall: 0.5690 - precision: 0.7142
 8/75 [==>...........................] - ETA: 1s - loss: 0.9117 - acc: 0.5437
- recall: 0.5980 - precision: 0.7407Epoch 5/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7997 - acc: 0.
5363 - recall: 0.5750 - precision: 0.7265
Epoch 4/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8089 - acc: 0.
5624 - recall: 0.6279 - precision: 0.7276
```

```
Epoch 4/45
75/75 [==============================] - 2s 27ms/step - loss: 1.0268 - acc: 0.
4817 - recall: 0.5191 - precision: 0.6817
Epoch 5/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8077 - acc: 0.
5261 - recall: 0.5675 - precision: 0.7126
 7/75 [=>............................] - ETA: 1s - loss: 1.0457 - acc: 0.4843
- recall: 0.5455 - precision: 0.6781Epoch 5/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9300 - acc: 0.
5127 - recall: 0.5556 - precision: 0.7075
18/75 [======>.......................] - ETA: 1s - loss: 0.8167 - acc: 0.5461
- recall: 0.5841 - precision: 0.7314Epoch 4/45
75/75 [==============================] - 2s 27ms/step - loss: 1.0091 - acc: 0.
5402 - recall: 0.5883 - precision: 0.7188
44/75 [================>.............] - ETA: 0s - loss: 0.8379 - acc: 0.5530
- recall: 0.6259 - precision: 0.7159Epoch 4/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8298 - acc: 0.
5710 - recall: 0.6496 - precision: 0.7277
Epoch 5/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8237 - acc: 0.
5702 - recall: 0.6540 - precision: 0.7231
51/75 [===================>..........] - ETA: 0s - loss: 0.7953 - acc: 0.5251
- recall: 0.5599 - precision: 0.7195Epoch 6/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8376 - acc: 0.
5599 - recall: 0.6336 - precision: 0.7188
54/75 [====================>.........] - ETA: 0s - loss: 0.7974 - acc: 0.5248
- recall: 0.5616 - precision: 0.7158Epoch 5/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9753 - acc: 0.
5144 - recall: 0.5570 - precision: 0.7070
Epoch 6/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8984 - acc: 0.
5300 - recall: 0.5533 - precision: 0.7292
75/75 [==============================] - 2s 30ms/step - loss: 0.9630 - acc: 0.
5438 - recall: 0.5876 - precision: 0.7288
Epoch 5/45
Epoch 5/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7982 - acc: 0.
5480 - recall: 0.5844 - precision: 0.7360
Epoch 5/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8007 - acc: 0.
5627 - recall: 0.6235 - precision: 0.7303
45/75 [================>.............] - ETA: 0s - loss: 1.0166 - acc: 0.5429
- recall: 0.5856 - precision: 0.7279Epoch 5/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8009 - acc: 0.
5264 - recall: 0.5649 - precision: 0.7144
Epoch 6/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9023 - acc: 0.
5120 - recall: 0.5483 - precision: 0.7106
Epoch 5/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9845 - acc: 0.
4868 - recall: 0.5172 - precision: 0.6890
29/75 [==========>...................] - ETA: 1s - loss: 0.8148 - acc: 0.5797
- recall: 0.6644 - precision: 0.7262Epoch 6/45
75/75 [==============================] - 2s 27ms/step - loss: 1.0062 - acc: 0.
5478 - recall: 0.5887 - precision: 0.7281
23/75 [========>.....................] - ETA: 1s - loss: 0.8044 - acc: 0.5291
- recall: 0.5669 - precision: 0.7178Epoch 5/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8188 - acc: 0.
5712 - recall: 0.6462 - precision: 0.7297
56/75 [=====================>........] - ETA: 0s - loss: 0.8027 - acc: 0.5516
```

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- recall: 0.6078 - precision: 0.7276Epoch 6/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8180 - acc: 0.
5675 - recall: 0.6486 - precision: 0.7228
73/75 [============================>.] - ETA: 0s - loss: 0.8177 - acc: 0.5753
- recall: 0.6463 - precision: 0.7301Epoch 7/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8188 - acc: 0.
5732 - recall: 0.6449 - precision: 0.7283
Epoch 6/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8969 - acc: 0.
5260 - recall: 0.5476 - precision: 0.7273
Epoch 6/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9730 - acc: 0.
5229 - recall: 0.5726 - precision: 0.7094
 5/75 [=>............................] - ETA: 1s - loss: 0.9696 - acc: 0.4940
- recall: 0.5230 - precision: 0.6766Epoch 7/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9434 - acc: 0.
5519 - recall: 0.6010 - precision: 0.7313
Epoch 6/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8013 - acc: 0.
5536 - recall: 0.6129 - precision: 0.7251
14/75 [====>.........................] - ETA: 1s - loss: 0.8389 - acc: 0.5543
- recall: 0.6341 - precision: 0.7122Epoch 6/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7944 - acc: 0.
5415 - recall: 0.5804 - precision: 0.7300
 1/75 [..............................] - ETA: 0s - loss: 0.6647 - acc: 0.6600
- recall: 0.6986 - precision: 0.8095Epoch 6/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7948 - acc: 0.
5261 - recall: 0.5634 - precision: 0.7149
24/75 [========>.....................] - ETA: 1s - loss: 0.7980 - acc: 0.5808
- recall: 0.6437 - precision: 0.7445Epoch 7/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9605 - acc: 0.
4871 - recall: 0.5129 - precision: 0.6915
 4/75 [>.............................] - ETA: 1s - loss: 0.7602 - acc: 0.5025
- recall: 0.5430 - precision: 0.7289Epoch 7/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9075 - acc: 0.
5060 - recall: 0.5377 - precision: 0.7087
Epoch 6/45
75/75 [==============================] - 2s 29ms/step - loss: 1.0042 - acc: 0.
5460 - recall: 0.5870 - precision: 0.7268
Epoch 6/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8070 - acc: 0.
5768 - recall: 0.6596 - precision: 0.7277
41/75 [===============>..............] - ETA: 0s - loss: 0.8919 - acc: 0.5066
- recall: 0.5387 - precision: 0.7041Epoch 8/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8056 - acc: 0.
5772 - recall: 0.6479 - precision: 0.7358
Epoch 7/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8356 - acc: 0.
5639 - recall: 0.6382 - precision: 0.7211
 3/75 [>.............................] - ETA: 4s - loss: 0.8294 - acc: 0.5833
- recall: 0.6731 - precision: 0.7107Epoch 7/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9735 - acc: 0.
5173 - recall: 0.5672 - precision: 0.7053
74/75 [============================>.] - ETA: 0s - loss: 0.7825 - acc: 0.5569
- recall: 0.6096 - precision: 0.7307Epoch 8/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7828 - acc: 0.
5559 - recall: 0.6085 - precision: 0.7303
12/75 [===>..........................] - ETA: 1s - loss: 0.8287 - acc: 0.5783
- recall: 0.6609 - precision: 0.7283Epoch 7/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8852 - acc: 0.
```

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5208 - recall: 0.5376 - precision: 0.7264
Epoch 7/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7850 - acc: 0.
5418 - recall: 0.5774 - precision: 0.7321
73/75 [============================>.] - ETA: 0s - loss: 0.9572 - acc: 0.5458
- recall: 0.5943 - precision: 0.7272Epoch 7/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7906 - acc: 0.
5221 - recall: 0.5502 - precision: 0.7171
64/75 [========================>.....] - ETA: 0s - loss: 0.9685 - acc: 0.4795
- recall: 0.5052 - precision: 0.6866Epoch 8/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9566 - acc: 0.
5466 - recall: 0.5953 - precision: 0.7279
Epoch 7/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9579 - acc: 0.
4805 - recall: 0.5040 - precision: 0.6876
21/75 [=======>......................] - ETA: 1s - loss: 0.8499 - acc: 0.5162
- recall: 0.5263 - precision: 0.7308Epoch 8/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8842 - acc: 0.
5033 - recall: 0.5344 - precision: 0.7070
Epoch 7/45
75/75 [==============================] - 2s 28ms/step - loss: 1.0036 - acc: 0.
5496 - recall: 0.5952 - precision: 0.7268
32/75 [===========>..................] - ETA: 1s - loss: 0.7570 - acc: 0.5484
- recall: 0.5752 - precision: 0.7460Epoch 7/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8177 - acc: 0.
5696 - recall: 0.6488 - precision: 0.7251
62/75 [=======================>......] - ETA: 0s - loss: 0.9917 - acc: 0.5239
- recall: 0.5671 - precision: 0.7115Epoch 9/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8228 - acc: 0.
5783 - recall: 0.6545 - precision: 0.7335
50/75 [===================>..........] - ETA: 0s - loss: 0.7922 - acc: 0.5160
- recall: 0.5383 - precision: 0.7103Epoch 8/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8703 - acc: 0.
5101 - recall: 0.5241 - precision: 0.7200
75/75 [==============================] - 2s 33ms/step - loss: 0.8302 - acc: 0.
5574 - recall: 0.6278 - precision: 0.7188
75/75 [==============================] - 2s 32ms/step - loss: 0.9871 - acc: 0.
5259 - recall: 0.5690 - precision: 0.7149
60/75 [=======================>......] - ETA: 0s - loss: 0.7888 - acc: 0.5150
- recall: 0.5377 - precision: 0.7140Epoch 8/45
Epoch 9/45
26/75 [=========>....................] - ETA: 2s - loss: 0.9972 - acc: 0.5573
- recall: 0.6023 - precision: 0.7324Epoch 8/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7905 - acc: 0.
5472 - recall: 0.5926 - precision: 0.7285
 4/75 [>.............................] - ETA: 1s - loss: 0.9524 - acc: 0.5150
- recall: 0.5326 - precision: 0.6934Epoch 8/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9530 - acc: 0.
5500 - recall: 0.5984 - precision: 0.7304
 1/75 [.............................] - ETA: 1s - loss: 0.7724 - acc: 0.5800
- recall: 0.6143 - precision: 0.7414Epoch 8/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7731 - acc: 0.
5454 - recall: 0.5726 - precision: 0.7397
61/75 [=======================>......] - ETA: 0s - loss: 0.9284 - acc: 0.4757
- recall: 0.4927 - precision: 0.6867Epoch 8/45
75/75 [==============================] - 3s 34ms/step - loss: 0.7823 - acc: 0.
5189 - recall: 0.5414 - precision: 0.7178
 8/75 [==>...........................] - ETA: 2s - loss: 0.7604 - acc: 0.5662
- recall: 0.6210 - precision: 0.7490Epoch 9/45
75/75 [==============================] - 2s 32ms/step - loss: 0.9271 - acc: 0.
```

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4784 - recall: 0.4956 - precision: 0.6891
47/75 [=================>............] - ETA: 1s - loss: 1.0048 - acc: 0.5436
- recall: 0.5849 - precision: 0.7275Epoch 9/45
75/75 [==============================] - 2s 33ms/step - loss: 0.8764 - acc: 0.
5033 - recall: 0.5298 - precision: 0.7096
 6/75 [=>............................] - ETA: 1s - loss: 0.8713 - acc: 0.4917
- recall: 0.5011 - precision: 0.7157Epoch 8/45
75/75 [==============================] - 3s 34ms/step - loss: 1.0126 - acc: 0.
5414 - recall: 0.5831 - precision: 0.7232
49/75 [==================>...........] - ETA: 0s - loss: 0.9512 - acc: 0.5531
- recall: 0.6009 - precision: 0.7297Epoch 8/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8152 - acc: 0.
5679 - recall: 0.6501 - precision: 0.7225
Epoch 10/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8141 - acc: 0.
5778 - recall: 0.6509 - precision: 0.7348
Epoch 9/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9637 - acc: 0.
5245 - recall: 0.5681 - precision: 0.7137
Epoch 10/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8601 - acc: 0.
5219 - recall: 0.5307 - precision: 0.7321
73/75 [============================>.] - ETA: 0s - loss: 0.8235 - acc: 0.5664
- recall: 0.6360 - precision: 0.7241Epoch 9/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8198 - acc: 0.
5674 - recall: 0.6362 - precision: 0.7261
71/75 [===========================>..] - ETA: 0s - loss: 0.9395 - acc: 0.5490
- recall: 0.5982 - precision: 0.7292Epoch 9/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7791 - acc: 0.
5518 - recall: 0.5966 - precision: 0.7318
27/75 [=========>....................] - ETA: 1s - loss: 0.9601 - acc: 0.5459
- recall: 0.5897 - precision: 0.7318Epoch 9/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9413 - acc: 0.
5471 - recall: 0.5964 - precision: 0.7279
Epoch 9/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7822 - acc: 0.
5125 - recall: 0.5353 - precision: 0.7129
75/75 [==============================] - 2s 29ms/step - loss: 0.7765 - acc: 0.
5362 - recall: 0.5684 - precision: 0.7302
Epoch 10/45
Epoch 9/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9165 - acc: 0.
4692 - recall: 0.4833 - precision: 0.6832
Epoch 10/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8699 - acc: 0.
5035 - recall: 0.5292 - precision: 0.7101
Epoch 9/45
75/75 [==============================] - 2s 27ms/step - loss: 1.0038 - acc: 0.
5419 - recall: 0.5872 - precision: 0.7216
42/75 [===============>..............] - ETA: 0s - loss: 0.7919 - acc: 0.5224
- recall: 0.5566 - precision: 0.7164Epoch 9/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8217 - acc: 0.
5624 - recall: 0.6461 - precision: 0.7184
62/75 [=======================>......] - ETA: 0s - loss: 0.9350 - acc: 0.5510
- recall: 0.5954 - precision: 0.7344Epoch 11/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9644 - acc: 0.
5219 - recall: 0.5620 - precision: 0.7137
Epoch 11/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8229 - acc: 0.
5823 - recall: 0.6536 - precision: 0.7385
```

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Epoch 10/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8567 - acc: 0.
5165 - recall: 0.5250 - precision: 0.7283
Epoch 10/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8223 - acc: 0.
5603 - recall: 0.6299 - precision: 0.7212
70/75 [===========================>..] - ETA: 0s - loss: 0.7935 - acc: 0.5126
- recall: 0.5362 - precision: 0.7109Epoch 10/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9387 - acc: 0.
5472 - recall: 0.5901 - precision: 0.7316
Epoch 10/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7924 - acc: 0.
5112 - recall: 0.5344 - precision: 0.7116
Epoch 11/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7777 - acc: 0.
5478 - recall: 0.5916 - precision: 0.7297
51/75 [===================>.........] - ETA: 0s - loss: 0.8624 - acc: 0.5125
- recall: 0.5310 - precision: 0.7146Epoch 10/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7742 - acc: 0.
5305 - recall: 0.5604 - precision: 0.7276
Epoch 10/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8966 - acc: 0.
4749 - recall: 0.4830 - precision: 0.6912
16/75 [=====>........................] - ETA: 1s - loss: 0.7772 - acc: 0.5194
- recall: 0.5509 - precision: 0.7036Epoch 11/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8517 - acc: 0.
5100 - recall: 0.5265 - precision: 0.7205
35/75 [=============>................] - ETA: 1s - loss: 0.8571 - acc: 0.5186
- recall: 0.5155 - precision: 0.7287Epoch 10/45
75/75 [==============================] - 2s 28ms/step - loss: 1.0061 - acc: 0.
5403 - recall: 0.5802 - precision: 0.7235
Epoch 10/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8196 - acc: 0.
5679 - recall: 0.6451 - precision: 0.7250
Epoch 12/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8203 - acc: 0.
5692 - recall: 0.6392 - precision: 0.7311
 2/75 [..............................] - ETA: 8s - loss: 0.8714 - acc: 0.5500
- recall: 0.6143 - precision: 0.7049Epoch 11/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9404 - acc: 0.
5228 - recall: 0.5652 - precision: 0.7132
Epoch 12/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8381 - acc: 0.
5586 - recall: 0.6323 - precision: 0.7180
62/75 [=======================>......] - ETA: 0s - loss: 0.8949 - acc: 0.4734
- recall: 0.4786 - precision: 0.6911Epoch 11/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8442 - acc: 0.
5159 - recall: 0.5159 - precision: 0.7332
75/75 [==============================] - 2s 27ms/step - loss: 0.9438 - acc: 0.
5447 - recall: 0.5881 - precision: 0.7296
Epoch 11/45
Epoch 11/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7715 - acc: 0.
5136 - recall: 0.5325 - precision: 0.7159
Epoch 12/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7689 - acc: 0.
5444 - recall: 0.5859 - precision: 0.7288
20/75 [=======>......................] - ETA: 1s - loss: 0.8294 - acc: 0.5585
- recall: 0.6342 - precision: 0.7120Epoch 11/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8895 - acc: 0.
```

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4705 - recall: 0.4742 - precision: 0.6899
Epoch 12/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7688 - acc: 0.
5311 - recall: 0.5569 - precision: 0.7304
52/75 [===================>..........] - ETA: 0s - loss: 0.8464 - acc: 0.5063
- recall: 0.5247 - precision: 0.7137Epoch 11/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8509 - acc: 0.
4988 - recall: 0.5134 - precision: 0.7130
Epoch 11/45
75/75 [==============================] - 2s 29ms/step - loss: 1.0048 - acc: 0.
5458 - recall: 0.5911 - precision: 0.7242
Epoch 11/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8056 - acc: 0.
5707 - recall: 0.6490 - precision: 0.7262
 1/75 [..............................] - ETA: 1s - loss: 1.1236 - acc: 0.5800
- recall: 0.6714 - precision: 0.7121Epoch 13/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8096 - acc: 0.
5834 - recall: 0.6518 - precision: 0.7408
Epoch 12/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9507 - acc: 0.
5263 - recall: 0.5700 - precision: 0.7149
Epoch 13/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7769 - acc: 0.
5073 - recall: 0.5260 - precision: 0.7112
75/75 [==============================] - 2s 27ms/step - loss: 0.8197 - acc: 0.
5676 - recall: 0.6375 - precision: 0.7257
Epoch 13/45
Epoch 12/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9517 - acc: 0.
5386 - recall: 0.5857 - precision: 0.7233
Epoch 12/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8310 - acc: 0.
5163 - recall: 0.5222 - precision: 0.7297
 5/75 [=>............................] - ETA: 1s - loss: 1.0430 - acc: 0.5260
- recall: 0.6085 - precision: 0.6879Epoch 12/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7729 - acc: 0.
5439 - recall: 0.5796 - precision: 0.7317
Epoch 12/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8885 - acc: 0.
4653 - recall: 0.4766 - precision: 0.6814
68/75 [==========================>...] - ETA: 0s - loss: 0.7703 - acc: 0.5294
- recall: 0.5520 - precision: 0.7305Epoch 13/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7677 - acc: 0.
5300 - recall: 0.5538 - precision: 0.7309
11/75 [===>..........................] - ETA: 2s - loss: 0.9735 - acc: 0.5355
- recall: 0.5990 - precision: 0.7179Epoch 12/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8327 - acc: 0.
5011 - recall: 0.5198 - precision: 0.7123
21/75 [=======>......................] - ETA: 1s - loss: 0.9138 - acc: 0.4448
- recall: 0.4506 - precision: 0.6484Epoch 12/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8093 - acc: 0.
5700 - recall: 0.6509 - precision: 0.7245
51/75 [===================>..........] - ETA: 0s - loss: 0.8070 - acc: 0.5724
- recall: 0.6416 - precision: 0.7296Epoch 14/45
75/75 [==============================] - 2s 33ms/step - loss: 0.9895 - acc: 0.
5412 - recall: 0.5869 - precision: 0.7210
38/75 [==============>...............] - ETA: 1s - loss: 0.7630 - acc: 0.5311
- recall: 0.5486 - precision: 0.7406Epoch 12/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8055 - acc: 0.
5796 - recall: 0.6481 - precision: 0.7384
```

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44/75 [================>.............] - ETA: 0s - loss: 0.7696 - acc: 0.5293
- recall: 0.5435 - precision: 0.7376Epoch 13/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9520 - acc: 0.
5168 - recall: 0.5579 - precision: 0.7095
 1/75 [..............................] - ETA: 10s - loss: 0.9266 - acc: 0.5500
- recall: 0.5890 - precision: 0.7414Epoch 14/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7679 - acc: 0.
5107 - recall: 0.5275 - precision: 0.7149
57/75 [=====================>........] - ETA: 0s - loss: 0.8671 - acc: 0.4684
- recall: 0.4680 - precision: 0.6915Epoch 14/45
75/75 [==============================] - 2s 33ms/step - loss: 0.8110 - acc: 0.
5700 - recall: 0.6392 - precision: 0.7276
Epoch 13/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7621 - acc: 0.
5510 - recall: 0.5859 - precision: 0.7371
74/75 [============================>.] - ETA: 0s - loss: 0.8340 - acc: 0.5116
- recall: 0.5218 - precision: 0.7242Epoch 13/45
75/75 [==============================] - 3s 35ms/step - loss: 0.9304 - acc: 0.
5428 - recall: 0.5883 - precision: 0.7272
75/75 [==============================] - 3s 34ms/step - loss: 0.8367 - acc: 0.
5111 - recall: 0.5211 - precision: 0.7231
15/75 [=====>........................] - ETA: 1s - loss: 0.7611 - acc: 0.5087
- recall: 0.5268 - precision: 0.7274Epoch 13/45
31/75 [===========>..................] - ETA: 1s - loss: 0.8123 - acc: 0.5674
- recall: 0.6411 - precision: 0.7229Epoch 13/45
75/75 [==============================] - 3s 33ms/step - loss: 0.8641 - acc: 0.
4732 - recall: 0.4725 - precision: 0.6946
22/75 [=======>......................] - ETA: 1s - loss: 0.8119 - acc: 0.5959
- recall: 0.6734 - precision: 0.7404Epoch 14/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7645 - acc: 0.
5315 - recall: 0.5471 - precision: 0.7370
Epoch 13/45
75/75 [==============================] - 3s 34ms/step - loss: 0.8296 - acc: 0.
5011 - recall: 0.5139 - precision: 0.7158
Epoch 13/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8098 - acc: 0.
5728 - recall: 0.6516 - precision: 0.7273
Epoch 15/45
75/75 [==============================] - 2s 24ms/step - loss: 0.9500 - acc: 0.
5281 - recall: 0.5709 - precision: 0.7167
34/75 [============>.................] - ETA: 1s - loss: 0.7550 - acc: 0.5312
- recall: 0.5461 - precision: 0.7381Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9859 - acc: 0.
5423 - recall: 0.5813 - precision: 0.7254
55/75 [=====================>........] - ETA: 0s - loss: 0.7577 - acc: 0.5449
- recall: 0.5765 - precision: 0.7364Epoch 13/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7704 - acc: 0.
5108 - recall: 0.5206 - precision: 0.7191
16/75 [=====>........................] - ETA: 1s - loss: 0.8145 - acc: 0.5506
- recall: 0.6334 - precision: 0.7118Epoch 15/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8121 - acc: 0.
5786 - recall: 0.6494 - precision: 0.7365
63/75 [========================>.....] - ETA: 0s - loss: 0.7640 - acc: 0.5408
- recall: 0.5715 - precision: 0.7333Epoch 14/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8131 - acc: 0.
5608 - recall: 0.6286 - precision: 0.7224
Epoch 14/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7608 - acc: 0.
5455 - recall: 0.5753 - precision: 0.7363
11/75 [===>..........................] - ETA: 1s - loss: 0.8178 - acc: 0.5800
```

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- recall: 0.6582 - precision: 0.7268Epoch 14/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9260 - acc: 0.
5484 - recall: 0.5872 - precision: 0.7349
75/75 [==============================] - 2s 27ms/step - loss: 0.8241 - acc: 0.
5100 - recall: 0.5085 - precision: 0.7296
Epoch 14/45
26/75 [=========>....................] - ETA: 1s - loss: 1.0681 - acc: 0.5273
- recall: 0.5732 - precision: 0.7051Epoch 14/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8571 - acc: 0.
4740 - recall: 0.4697 - precision: 0.6973
34/75 [============>.................] - ETA: 1s - loss: 0.9511 - acc: 0.5174
- recall: 0.5620 - precision: 0.7124Epoch 15/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7545 - acc: 0.
5326 - recall: 0.5508 - precision: 0.7361
32/75 [===========>..................] - ETA: 1s - loss: 0.7681 - acc: 0.5131
- recall: 0.5354 - precision: 0.7116Epoch 14/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8310 - acc: 0.
4928 - recall: 0.5012 - precision: 0.7119
38/75 [==============>...............] - ETA: 0s - loss: 0.8267 - acc: 0.5068
- recall: 0.5050 - precision: 0.7175Epoch 14/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9664 - acc: 0.
5171 - recall: 0.5609 - precision: 0.7083
35/75 [=============>................] - ETA: 1s - loss: 0.8711 - acc: 0.4634
- recall: 0.4588 - precision: 0.6712Epoch 16/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8083 - acc: 0.
5712 - recall: 0.6535 - precision: 0.7245
 1/75 [..............................] - ETA: 1s - loss: 0.9273 - acc: 0.4900
- recall: 0.4776 - precision: 0.6667Epoch 16/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7703 - acc: 0.
5019 - recall: 0.5142 - precision: 0.7106
45/75 [=================>............] - ETA: 0s - loss: 0.9440 - acc: 0.5616
- recall: 0.6078 - precision: 0.7411Epoch 16/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9972 - acc: 0.
5463 - recall: 0.5880 - precision: 0.7266
Epoch 14/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8100 - acc: 0.
5774 - recall: 0.6470 - precision: 0.7364
46/75 [=================>............] - ETA: 0s - loss: 0.7640 - acc: 0.5272
- recall: 0.5477 - precision: 0.7338Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7607 - acc: 0.
5431 - recall: 0.5742 - precision: 0.7339
Epoch 15/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8152 - acc: 0.
5640 - recall: 0.6336 - precision: 0.7236
Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8178 - acc: 0.
5065 - recall: 0.5041 - precision: 0.7275
34/75 [============>.................] - ETA: 1s - loss: 0.8024 - acc: 0.5691
- recall: 0.6379 - precision: 0.7356Epoch 15/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8535 - acc: 0.
4648 - recall: 0.4616 - precision: 0.6888
28/75 [==========>...................] - ETA: 1s - loss: 0.9893 - acc: 0.5404
- recall: 0.5723 - precision: 0.7238Epoch 16/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9560 - acc: 0.
5550 - recall: 0.6010 - precision: 0.7350
43/75 [================>.............] - ETA: 0s - loss: 0.8087 - acc: 0.5665
- recall: 0.6366 - precision: 0.7286Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7563 - acc: 0.
5304 - recall: 0.5433 - precision: 0.7380
Epoch 15/45
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75/75 [==============================] - 2s 26ms/step - loss: 0.9438 - acc: 0.
5237 - recall: 0.5639 - precision: 0.7150
Epoch 17/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8145 - acc: 0.
4939 - recall: 0.4988 - precision: 0.7149
60/75 [=======================>......] - ETA: 0s - loss: 0.9937 - acc: 0.5365
- recall: 0.5745 - precision: 0.7211Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8055 - acc: 0.
5654 - recall: 0.6387 - precision: 0.7254
 3/75 [>.............................] - ETA: 3s - loss: 0.9780 - acc: 0.4833
- recall: 0.5263 - precision: 0.6627Epoch 17/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8197 - acc: 0.
5687 - recall: 0.6403 - precision: 0.7299
Epoch 16/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9876 - acc: 0.
5391 - recall: 0.5781 - precision: 0.7231
Epoch 15/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7648 - acc: 0.
5023 - recall: 0.5098 - precision: 0.7138
Epoch 17/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8155 - acc: 0.
5704 - recall: 0.6399 - precision: 0.7277
11/75 [===>..........................] - ETA: 2s - loss: 0.7736 - acc: 0.5755
- recall: 0.6349 - precision: 0.7489Epoch 16/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7605 - acc: 0.
5296 - recall: 0.5550 - precision: 0.7277
27/75 [=========>....................] - ETA: 1s - loss: 0.8134 - acc: 0.5763
- recall: 0.6618 - precision: 0.7188Epoch 16/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8245 - acc: 0.
5004 - recall: 0.5022 - precision: 0.7198
34/75 [============>.................] - ETA: 1s - loss: 0.8137 - acc: 0.5741
- recall: 0.6592 - precision: 0.7164Epoch 16/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9282 - acc: 0.
5476 - recall: 0.5907 - precision: 0.7318
Epoch 16/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8470 - acc: 0.
4636 - recall: 0.4563 - precision: 0.6900
Epoch 17/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7559 - acc: 0.
5247 - recall: 0.5447 - precision: 0.7292
Epoch 16/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9367 - acc: 0.
5205 - recall: 0.5598 - precision: 0.7132
63/75 [========================>.....] - ETA: 0s - loss: 0.7541 - acc: 0.5057
- recall: 0.5061 - precision: 0.7207Epoch 18/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8115 - acc: 0.
5675 - recall: 0.6475 - precision: 0.7233
 6/75 [=>............................] - ETA: 1s - loss: 0.9816 - acc: 0.5017
- recall: 0.5535 - precision: 0.6899Epoch 18/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9920 - acc: 0.
5411 - recall: 0.5885 - precision: 0.7199
59/75 [======================>.......] - ETA: 0s - loss: 0.8218 - acc: 0.5603
- recall: 0.6288 - precision: 0.7198Epoch 16/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8089 - acc: 0.
5016 - recall: 0.5113 - precision: 0.7181
 8/75 [==>...........................] - ETA: 2s - loss: 0.9805 - acc: 0.4988
- recall: 0.5523 - precision: 0.6876Epoch 16/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7557 - acc: 0.
5057 - recall: 0.5057 - precision: 0.7212
Epoch 18/45
```

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75/75 [==============================] - 2s 29ms/step - loss: 0.8084 - acc: 0.
5748 - recall: 0.6464 - precision: 0.7338
Epoch 17/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8184 - acc: 0.
5604 - recall: 0.6276 - precision: 0.7225
Epoch 17/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7523 - acc: 0.
5380 - recall: 0.5652 - precision: 0.7327
31/75 [===========>..................] - ETA: 1s - loss: 0.8100 - acc: 0.5681
- recall: 0.6500 - precision: 0.7240Epoch 17/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8051 - acc: 0.
5021 - recall: 0.4937 - precision: 0.7279
32/75 [===========>..................] - ETA: 1s - loss: 0.8065 - acc: 0.5059
- recall: 0.5110 - precision: 0.7255Epoch 17/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8405 - acc: 0.
4570 - recall: 0.4504 - precision: 0.6839
36/75 [=============>................] - ETA: 1s - loss: 0.9682 - acc: 0.5125
- recall: 0.5584 - precision: 0.6983Epoch 18/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9183 - acc: 0.
5494 - recall: 0.5913 - precision: 0.7337
68/75 [==========================>...] - ETA: 0s - loss: 0.7490 - acc: 0.5318
- recall: 0.5414 - precision: 0.7398Epoch 17/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7458 - acc: 0.
5314 - recall: 0.5400 - precision: 0.7415
10/75 [===>..........................] - ETA: 1s - loss: 0.8046 - acc: 0.5100
- recall: 0.5083 - precision: 0.7351Epoch 17/45
75/75 [==============================] - 2s 32ms/step - loss: 0.9604 - acc: 0.
5128 - recall: 0.5559 - precision: 0.7056
27/75 [=========>....................] - ETA: 1s - loss: 0.7657 - acc: 0.5337
- recall: 0.5391 - precision: 0.7331Epoch 19/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8009 - acc: 0.
5666 - recall: 0.6449 - precision: 0.7236
59/75 [======================>.......] - ETA: 0s - loss: 0.8207 - acc: 0.5663
- recall: 0.6378 - precision: 0.7272Epoch 19/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8031 - acc: 0.
5004 - recall: 0.5023 - precision: 0.7220
Epoch 17/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7573 - acc: 0.
4919 - recall: 0.4919 - precision: 0.7098
11/75 [===>..........................] - ETA: 1s - loss: 0.9296 - acc: 0.5236
- recall: 0.5670 - precision: 0.7179Epoch 19/45
75/75 [==============================] - 3s 32ms/step - loss: 0.9626 - acc: 0.
5442 - recall: 0.5839 - precision: 0.7263
71/75 [===========================>..] - ETA: 0s - loss: 0.8164 - acc: 0.5700
- recall: 0.6407 - precision: 0.7309Epoch 17/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8172 - acc: 0.
5696 - recall: 0.6405 - precision: 0.7309
Epoch 18/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8142 - acc: 0.
5639 - recall: 0.6287 - precision: 0.7259
Epoch 18/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8363 - acc: 0.
4616 - recall: 0.4504 - precision: 0.6906
24/75 [========>.....................] - ETA: 1s - loss: 0.8164 - acc: 0.4929
- recall: 0.4899 - precision: 0.7166Epoch 19/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7522 - acc: 0.
5348 - recall: 0.5576 - precision: 0.7330
Epoch 18/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8074 - acc: 0.
5085 - recall: 0.4996 - precision: 0.7334
```

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39/75 [==============>..............] - ETA: 0s - loss: 0.9394 - acc: 0.5210
- recall: 0.5643 - precision: 0.7140Epoch 18/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9354 - acc: 0.
5402 - recall: 0.5818 - precision: 0.7275
Epoch 18/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7485 - acc: 0.
5297 - recall: 0.5392 - precision: 0.7397
Epoch 18/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9483 - acc: 0.
5205 - recall: 0.5592 - precision: 0.7135
47/75 [=================>............] - ETA: 0s - loss: 0.8036 - acc: 0.5638
- recall: 0.6310 - precision: 0.7273Epoch 20/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8021 - acc: 0.
4987 - recall: 0.5018 - precision: 0.7199
Epoch 18/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8072 - acc: 0.
5683 - recall: 0.6459 - precision: 0.7251
53/75 [====================>.........] - ETA: 0s - loss: 0.8145 - acc: 0.4634
- recall: 0.4475 - precision: 0.6934Epoch 20/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9839 - acc: 0.
5364 - recall: 0.5748 - precision: 0.7216
53/75 [====================>.........] - ETA: 0s - loss: 0.7486 - acc: 0.5377
- recall: 0.5551 - precision: 0.7366Epoch 18/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7510 - acc: 0.
5049 - recall: 0.4993 - precision: 0.7241
Epoch 20/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8028 - acc: 0.
5727 - recall: 0.6339 - precision: 0.7381
50/75 [===================>..........] - ETA: 0s - loss: 0.7339 - acc: 0.5398
- recall: 0.5473 - precision: 0.7576Epoch 19/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8182 - acc: 0.
5591 - recall: 0.6267 - precision: 0.7214
70/75 [===========================>..] - ETA: 0s - loss: 0.7478 - acc: 0.5393
- recall: 0.5584 - precision: 0.7378Epoch 19/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8170 - acc: 0.
4629 - recall: 0.4474 - precision: 0.6943
21/75 [=======>......................] - ETA: 1s - loss: 0.7670 - acc: 0.5090
- recall: 0.5111 - precision: 0.7133Epoch 20/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9349 - acc: 0.
5408 - recall: 0.5829 - precision: 0.7277
24/75 [========>.....................] - ETA: 1s - loss: 0.8131 - acc: 0.4808
- recall: 0.4917 - precision: 0.7058Epoch 19/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7463 - acc: 0.
5400 - recall: 0.5594 - precision: 0.7389
Epoch 19/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7388 - acc: 0.
5402 - recall: 0.5468 - precision: 0.7494
Epoch 19/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8017 - acc: 0.
5043 - recall: 0.4937 - precision: 0.7311
 6/75 [=>............................] - ETA: 2s - loss: 0.9160 - acc: 0.5117
- recall: 0.5463 - precision: 0.7246Epoch 19/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9410 - acc: 0.
5123 - recall: 0.5481 - precision: 0.7091
37/75 [=============>................] - ETA: 1s - loss: 0.8314 - acc: 0.4476
- recall: 0.4412 - precision: 0.6713Epoch 21/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8113 - acc: 0.
5666 - recall: 0.6448 - precision: 0.7237
Epoch 21/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7998 - acc: 0.
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4899 - recall: 0.4949 - precision: 0.7116
Epoch 19/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7538 - acc: 0.
4971 - recall: 0.4964 - precision: 0.7146
75/75 [==============================] - 2s 27ms/step - loss: 0.9788 - acc: 0.
5334 - recall: 0.5749 - precision: 0.7176
Epoch 19/45
45/75 [=================>............] - ETA: 0s - loss: 0.8080 - acc: 0.5024
- recall: 0.4907 - precision: 0.7292Epoch 21/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8071 - acc: 0.
5696 - recall: 0.6372 - precision: 0.7327
Epoch 20/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8111 - acc: 0.
5572 - recall: 0.6206 - precision: 0.7224
Epoch 20/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9112 - acc: 0.
5532 - recall: 0.5961 - precision: 0.7358
 1/75 [..............................] - ETA: 1s - loss: 0.8236 - acc: 0.6000
- recall: 0.6622 - precision: 0.7656Epoch 20/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8241 - acc: 0.
4478 - recall: 0.4355 - precision: 0.6788
Epoch 21/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7364 - acc: 0.
5447 - recall: 0.5687 - precision: 0.7394
 1/75 [..............................] - ETA: 1s - loss: 0.8777 - acc: 0.3900
- recall: 0.3662 - precision: 0.6190Epoch 20/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7888 - acc: 0.
5087 - recall: 0.4948 - precision: 0.7370
28/75 [==========>...................] - ETA: 1s - loss: 0.9730 - acc: 0.5336
- recall: 0.5747 - precision: 0.7206Epoch 20/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7390 - acc: 0.
5267 - recall: 0.5326 - precision: 0.7398
 6/75 [=>............................] - ETA: 1s - loss: 0.7347 - acc: 0.5350
- recall: 0.5312 - precision: 0.7752Epoch 20/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9544 - acc: 0.
5208 - recall: 0.5568 - precision: 0.7152
Epoch 22/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8067 - acc: 0.
5687 - recall: 0.6459 - precision: 0.7255
Epoch 22/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7906 - acc: 0.
4907 - recall: 0.4881 - precision: 0.7170
Epoch 20/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9713 - acc: 0.
5454 - recall: 0.5857 - precision: 0.7267
Epoch 20/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7550 - acc: 0.
4965 - recall: 0.4917 - precision: 0.7167
Epoch 22/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8090 - acc: 0.
5730 - recall: 0.6427 - precision: 0.7336
Epoch 21/45
75/75 [==============================] - 2s 26ms/step - loss: 0.8200 - acc: 0.
4478 - recall: 0.4264 - precision: 0.6840
72/75 [===========================>..] - ETA: 0s - loss: 0.7427 - acc: 0.5397
- recall: 0.5622 - precision: 0.7360Epoch 22/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7426 - acc: 0.
5410 - recall: 0.5631 - precision: 0.7378
Epoch 21/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8135 - acc: 0.
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5647 - recall: 0.6325 - precision: 0.7249
Epoch 21/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9293 - acc: 0.
5450 - recall: 0.5885 - precision: 0.7297
27/75 [=========>....................] - ETA: 1s - loss: 1.0071 - acc: 0.5352
- recall: 0.5788 - precision: 0.7123Epoch 21/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7876 - acc: 0.
5067 - recall: 0.4996 - precision: 0.7306
 1/75 [..............................] - ETA: 2s - loss: 0.8940 - acc: 0.5200
- recall: 0.5867 - precision: 0.7213Epoch 21/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7434 - acc: 0.
5221 - recall: 0.5263 - precision: 0.7375
 7/75 [=>............................] - ETA: 1s - loss: 0.9511 - acc: 0.5371
- recall: 0.5709 - precision: 0.7406Epoch 21/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9362 - acc: 0.
5227 - recall: 0.5613 - precision: 0.7151
36/75 [=============>................] - ETA: 0s - loss: 0.8246 - acc: 0.5669
- recall: 0.6371 - precision: 0.7256Epoch 23/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8069 - acc: 0.
5731 - recall: 0.6511 - precision: 0.7279
63/75 [========================>.....] - ETA: 0s - loss: 0.7941 - acc: 0.4805
- recall: 0.4806 - precision: 0.7105Epoch 23/45
75/75 [==============================] - 2s 24ms/step - loss: 0.7424 - acc: 0.
5005 - recall: 0.4941 - precision: 0.7210
Epoch 23/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7979 - acc: 0.
4828 - recall: 0.4833 - precision: 0.7086
Epoch 21/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9681 - acc: 0.
5334 - recall: 0.5770 - precision: 0.7165
Epoch 21/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8095 - acc: 0.
5698 - recall: 0.6400 - precision: 0.7313
 6/75 [=>............................] - ETA: 2s - loss: 0.9145 - acc: 0.5317
- recall: 0.5711 - precision: 0.7355Epoch 22/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8129 - acc: 0.
4489 - recall: 0.4260 - precision: 0.6859
72/75 [===========================>..] - ETA: 0s - loss: 0.7451 - acc: 0.5357
- recall: 0.5517 - precision: 0.7381Epoch 23/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7435 - acc: 0.
5368 - recall: 0.5526 - precision: 0.7389
39/75 [==============>...............] - ETA: 1s - loss: 0.9036 - acc: 0.5185
- recall: 0.5466 - precision: 0.7222Epoch 22/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9220 - acc: 0.
5463 - recall: 0.5881 - precision: 0.7316
15/75 [=====>........................] - ETA: 3s - loss: 0.8427 - acc: 0.5447
- recall: 0.6055 - precision: 0.7039Epoch 22/45
75/75 [==============================] - 2s 33ms/step - loss: 0.8198 - acc: 0.
5606 - recall: 0.6260 - precision: 0.7235
41/75 [===============>..............] - ETA: 1s - loss: 0.8021 - acc: 0.5705
- recall: 0.6421 - precision: 0.7284Epoch 22/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7848 - acc: 0.
5004 - recall: 0.4846 - precision: 0.7315
Epoch 22/45
75/75 [==============================] - 3s 33ms/step - loss: 0.7360 - acc: 0.
5172 - recall: 0.5228 - precision: 0.7328
Epoch 22/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9389 - acc: 0.
5145 - recall: 0.5481 - precision: 0.7120
52/75 [===================>..........] - ETA: 0s - loss: 0.7841 - acc: 0.4929
```

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- recall: 0.4913 - precision: 0.7173Epoch 24/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8085 - acc: 0.
5614 - recall: 0.6377 - precision: 0.7213
35/75 [=============>.............] - ETA: 1s - loss: 0.9196 - acc: 0.5403
- recall: 0.5817 - precision: 0.7204Epoch 24/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7459 - acc: 0.
4996 - recall: 0.4923 - precision: 0.7208
28/75 [==========>...................] - ETA: 1s - loss: 0.7338 - acc: 0.5204
- recall: 0.5126 - precision: 0.7446Epoch 24/45
75/75 [==============================] - 3s 34ms/step - loss: 0.7860 - acc: 0.
4933 - recall: 0.4885 - precision: 0.7207
Epoch 22/45
75/75 [==============================] - 3s 34ms/step - loss: 0.9824 - acc: 0.
5371 - recall: 0.5731 - precision: 0.7234
25/75 [=========>....................] - ETA: 1s - loss: 0.9830 - acc: 0.5020
- recall: 0.5487 - precision: 0.6906Epoch 22/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8086 - acc: 0.
4542 - recall: 0.4251 - precision: 0.6948
31/75 [===========>..................] - ETA: 1s - loss: 0.7959 - acc: 0.5677
- recall: 0.6415 - precision: 0.7224Epoch 24/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7427 - acc: 0.
5335 - recall: 0.5515 - precision: 0.7350
35/75 [=============>.............] - ETA: 1s - loss: 0.9784 - acc: 0.5046
- recall: 0.5483 - precision: 0.6927Epoch 23/45
75/75 [==============================] - 3s 34ms/step - loss: 0.8026 - acc: 0.
5687 - recall: 0.6293 - precision: 0.7359
30/75 [===========>..................] - ETA: 0s - loss: 0.7365 - acc: 0.4927
- recall: 0.4838 - precision: 0.7176Epoch 23/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8084 - acc: 0.
5646 - recall: 0.6269 - precision: 0.7277
73/75 [============================>.] - ETA: 0s - loss: 0.9282 - acc: 0.5412
- recall: 0.5818 - precision: 0.7289Epoch 23/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9278 - acc: 0.
5412 - recall: 0.5817 - precision: 0.7290
Epoch 23/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7820 - acc: 0.
5031 - recall: 0.4876 - precision: 0.7335
Epoch 23/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7402 - acc: 0.
5200 - recall: 0.5191 - precision: 0.7393
37/75 [=============>................] - ETA: 1s - loss: 0.7949 - acc: 0.4841
- recall: 0.4837 - precision: 0.7161Epoch 23/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9525 - acc: 0.
5153 - recall: 0.5566 - precision: 0.7084
75/75 [==============================] - 2s 24ms/step - loss: 0.7986 - acc: 0.
5659 - recall: 0.6440 - precision: 0.7233
50/75 [===================>..........] - ETA: 0s - loss: 0.7909 - acc: 0.4832
- recall: 0.4789 - precision: 0.7181Epoch 25/45
67/75 [=========================>....] - ETA: 0s - loss: 0.7451 - acc: 0.4936
- recall: 0.4831 - precision: 0.7180Epoch 25/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7437 - acc: 0.
4965 - recall: 0.4869 - precision: 0.7198
Epoch 25/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7873 - acc: 0.
4836 - recall: 0.4798 - precision: 0.7119
Epoch 23/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9588 - acc: 0.
5380 - recall: 0.5818 - precision: 0.7197
Epoch 23/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7968 - acc: 0.
```

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4516 - recall: 0.4245 - precision: 0.6909
Epoch 25/45
75/75 [==============================] - 2s 24ms/step - loss: 0.9131 - acc: 0.
5520 - recall: 0.5898 - precision: 0.7379
Epoch 24/45
75/75 [==============================] - 2s 22ms/step - loss: 0.8026 - acc: 0.
5683 - recall: 0.6407 - precision: 0.7277
35/75 [=============>................] - ETA: 0s - loss: 0.7968 - acc: 0.4451
- recall: 0.4174 - precision: 0.6947Epoch 26/45
75/75 [==============================] - 2s 20ms/step - loss: 0.9307 - acc: 0.
5227 - recall: 0.5603 - precision: 0.7156
Epoch 26/45
75/75 [==============================] - 3s 38ms/step - loss: 0.7450 - acc: 0.
5297 - recall: 0.5481 - precision: 0.7320
74/75 [============================>.] - ETA: 0s - loss: 0.8093 - acc: 0.5714
- recall: 0.6369 - precision: 0.7350Epoch 24/45
75/75 [==============================] - 3s 38ms/step - loss: 0.8105 - acc: 0.
5704 - recall: 0.6357 - precision: 0.7344
Epoch 24/45
75/75 [==============================] - 2s 22ms/step - loss: 0.7419 - acc: 0.
5020 - recall: 0.4953 - precision: 0.7224
Epoch 26/45
75/75 [==============================] - 3s 35ms/step - loss: 0.7766 - acc: 0.
4996 - recall: 0.4830 - precision: 0.7314
Epoch 24/45
75/75 [==============================] - 3s 37ms/step - loss: 0.8063 - acc: 0.
5552 - recall: 0.6168 - precision: 0.7219
 5/75 [=>............................] - ETA: 1s - loss: 0.7409 - acc: 0.4900
- recall: 0.4933 - precision: 0.7400Epoch 24/45
75/75 [==============================] - 3s 36ms/step - loss: 0.7342 - acc: 0.
5252 - recall: 0.5246 - precision: 0.7431
Epoch 24/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8040 - acc: 0.
4462 - recall: 0.4208 - precision: 0.6848
30/75 [===========>..................] - ETA: 1s - loss: 0.7912 - acc: 0.5680
- recall: 0.6312 - precision: 0.7411Epoch 26/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8979 - acc: 0.
5490 - recall: 0.5844 - precision: 0.7372
70/75 [===========================>..] - ETA: 0s - loss: 0.7802 - acc: 0.4916
- recall: 0.4880 - precision: 0.7182Epoch 25/45
75/75 [==============================] - 3s 38ms/step - loss: 0.7805 - acc: 0.
4904 - recall: 0.4868 - precision: 0.7174
 4/75 [>.............................] - ETA: 3s - loss: 0.9508 - acc: 0.5200
- recall: 0.5612 - precision: 0.7237Epoch 24/45
75/75 [==============================] - 3s 39ms/step - loss: 0.9615 - acc: 0.
5506 - recall: 0.5835 - precision: 0.7346
Epoch 24/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8049 - acc: 0.
5614 - recall: 0.6370 - precision: 0.7217
75/75 [==============================] - 2s 27ms/step - loss: 0.9359 - acc: 0.
5220 - recall: 0.5542 - precision: 0.7182
Epoch 27/45
61/75 [=======================>......] - ETA: 0s - loss: 0.7770 - acc: 0.4943
- recall: 0.4787 - precision: 0.7257Epoch 27/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7418 - acc: 0.
5008 - recall: 0.4902 - precision: 0.7239
Epoch 27/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7362 - acc: 0.
5339 - recall: 0.5398 - precision: 0.7431
75/75 [==============================] - 2s 30ms/step - loss: 0.7924 - acc: 0.
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5690 - recall: 0.6333 - precision: 0.7340
18/75 [======>.....................] - ETA: 1s - loss: 0.7668 - acc: 0.5739
- recall: 0.6393 - precision: 0.7425Epoch 25/45
Epoch 25/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7745 - acc: 0.
4952 - recall: 0.4782 - precision: 0.7280
29/75 [==========>...................] - ETA: 1s - loss: 0.7802 - acc: 0.4955
- recall: 0.4871 - precision: 0.7218Epoch 25/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8210 - acc: 0.
5538 - recall: 0.6219 - precision: 0.7177
 9/75 [==>...........................] - ETA: 2s - loss: 0.7998 - acc: 0.5944
- recall: 0.6579 - precision: 0.7469Epoch 25/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7356 - acc: 0.
5200 - recall: 0.5222 - precision: 0.7372
52/75 [===================>..........] - ETA: 0s - loss: 0.9053 - acc: 0.5415
- recall: 0.5798 - precision: 0.7324Epoch 25/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7969 - acc: 0.
4484 - recall: 0.4174 - precision: 0.6903
Epoch 27/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9133 - acc: 0.
5426 - recall: 0.5822 - precision: 0.7303
Epoch 26/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7823 - acc: 0.
4891 - recall: 0.4818 - precision: 0.7187
Epoch 25/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7946 - acc: 0.
5712 - recall: 0.6405 - precision: 0.7312
Epoch 28/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9521 - acc: 0.
5113 - recall: 0.5505 - precision: 0.7066
50/75 [===================>..........] - ETA: 0s - loss: 0.8152 - acc: 0.5740
- recall: 0.6430 - precision: 0.7329Epoch 28/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9646 - acc: 0.
5443 - recall: 0.5807 - precision: 0.7282
33/75 [============>.................] - ETA: 1s - loss: 0.8030 - acc: 0.4467
- recall: 0.4250 - precision: 0.6857Epoch 25/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7432 - acc: 0.
4996 - recall: 0.4876 - precision: 0.7239
Epoch 28/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7304 - acc: 0.
5470 - recall: 0.5585 - precision: 0.7490
Epoch 26/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8028 - acc: 0.
5754 - recall: 0.6414 - precision: 0.7371
40/75 [===============>..............] - ETA: 0s - loss: 0.9303 - acc: 0.5405
- recall: 0.5832 - precision: 0.7237Epoch 26/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7722 - acc: 0.
4961 - recall: 0.4724 - precision: 0.7335
24/75 [========>.....................] - ETA: 1s - loss: 0.9676 - acc: 0.5383
- recall: 0.5850 - precision: 0.7195Epoch 26/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8144 - acc: 0.
5515 - recall: 0.6137 - precision: 0.7192
Epoch 26/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7330 - acc: 0.
5176 - recall: 0.5200 - precision: 0.7352
12/75 [===>..........................] - ETA: 1s - loss: 0.7804 - acc: 0.4842
- recall: 0.4715 - precision: 0.7123Epoch 26/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7951 - acc: 0.
4536 - recall: 0.4262 - precision: 0.6930
Epoch 28/45
```

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75/75 [==============================] - 2s 32ms/step - loss: 0.7712 - acc: 0.
4937 - recall: 0.4818 - precision: 0.7257
60/75 [=====================>......] - ETA: 0s - loss: 0.9672 - acc: 0.5352
- recall: 0.5741 - precision: 0.7207Epoch 26/45
75/75 [==============================] - 2s 33ms/step - loss: 0.9139 - acc: 0.
5450 - recall: 0.5853 - precision: 0.7315
60/75 [=====================>......] - ETA: 0s - loss: 0.7362 - acc: 0.4988
- recall: 0.4890 - precision: 0.7253Epoch 27/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9528 - acc: 0.
5071 - recall: 0.5433 - precision: 0.7050
73/75 [============================>.] - ETA: 0s - loss: 0.8056 - acc: 0.5633
- recall: 0.6386 - precision: 0.7230Epoch 29/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8037 - acc: 0.
5642 - recall: 0.6387 - precision: 0.7240
Epoch 29/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7397 - acc: 0.
4995 - recall: 0.4872 - precision: 0.7239
75/75 [==============================] - 2s 31ms/step - loss: 0.9624 - acc: 0.
5371 - recall: 0.5762 - precision: 0.7216
Epoch 29/45
Epoch 26/45
75/75 [==============================] - 3s 34ms/step - loss: 0.7329 - acc: 0.
5297 - recall: 0.5413 - precision: 0.7363
31/75 [===========>..................] - ETA: 1s - loss: 0.9707 - acc: 0.5139
- recall: 0.5511 - precision: 0.7028Epoch 27/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7654 - acc: 0.
4975 - recall: 0.4778 - precision: 0.7318
75/75 [==============================] - 2s 32ms/step - loss: 0.8068 - acc: 0.
5643 - recall: 0.6232 - precision: 0.7294
59/75 [======================>.......] - ETA: 0s - loss: 0.7750 - acc: 0.4534
- recall: 0.4171 - precision: 0.7040Epoch 27/45
Epoch 27/45
75/75 [==============================] - 3s 34ms/step - loss: 0.8090 - acc: 0.
5660 - recall: 0.6293 - precision: 0.7327
32/75 [===========>..................] - ETA: 1s - loss: 0.9704 - acc: 0.5122
- recall: 0.5495 - precision: 0.7017Epoch 27/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7275 - acc: 0.
5265 - recall: 0.5243 - precision: 0.7453
Epoch 27/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7776 - acc: 0.
4534 - recall: 0.4165 - precision: 0.6991
46/75 [=================>............] - ETA: 0s - loss: 0.9651 - acc: 0.5372
- recall: 0.5728 - precision: 0.7211Epoch 29/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9154 - acc: 0.
5419 - recall: 0.5789 - precision: 0.7314
17/75 [=====>........................] - ETA: 1s - loss: 0.7210 - acc: 0.5135
- recall: 0.5076 - precision: 0.7482Epoch 28/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7733 - acc: 0.
4873 - recall: 0.4757 - precision: 0.7201
75/75 [==============================] - 2s 26ms/step - loss: 0.8024 - acc: 0.
5739 - recall: 0.6485 - precision: 0.7301
Epoch 30/45
65/75 [=========================>....] - ETA: 0s - loss: 0.7337 - acc: 0.5095
- recall: 0.4922 - precision: 0.7374Epoch 27/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9492 - acc: 0.
5113 - recall: 0.5465 - precision: 0.7088
27/75 [=========>....................] - ETA: 1s - loss: 0.7938 - acc: 0.4385
- recall: 0.4042 - precision: 0.6760Epoch 30/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7371 - acc: 0.
5091 - recall: 0.4930 - precision: 0.7345
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10/75 [===>..........................] - ETA: 2s - loss: 0.7909 - acc: 0.5660
- recall: 0.6361 - precision: 0.7346Epoch 30/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9628 - acc: 0.
5363 - recall: 0.5742 - precision: 0.7217
Epoch 27/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8029 - acc: 0.
5731 - recall: 0.6374 - precision: 0.7366
Epoch 28/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8111 - acc: 0.
5596 - recall: 0.6194 - precision: 0.7258
Epoch 28/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7603 - acc: 0.
5011 - recall: 0.4756 - precision: 0.7391
Epoch 28/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7318 - acc: 0.
5414 - recall: 0.5491 - precision: 0.7475
11/75 [===>..........................] - ETA: 1s - loss: 0.7876 - acc: 0.5809
- recall: 0.6497 - precision: 0.7346Epoch 28/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7875 - acc: 0.
4416 - recall: 0.4074 - precision: 0.6857
67/75 [=========================>....] - ETA: 0s - loss: 0.7243 - acc: 0.5249
- recall: 0.5166 - precision: 0.7451Epoch 30/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7219 - acc: 0.
5276 - recall: 0.5209 - precision: 0.7492
21/75 [=======>......................] - ETA: 1s - loss: 0.8103 - acc: 0.5738
- recall: 0.6420 - precision: 0.7300Epoch 28/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9254 - acc: 0.
5332 - recall: 0.5780 - precision: 0.7210
10/75 [===>..........................] - ETA: 1s - loss: 0.7452 - acc: 0.5070
- recall: 0.5063 - precision: 0.7251Epoch 29/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7985 - acc: 0.
5628 - recall: 0.6346 - precision: 0.7246
75/75 [==============================] - 2s 27ms/step - loss: 0.7632 - acc: 0.
4931 - recall: 0.4842 - precision: 0.7231
 2/75 [..............................] - ETA: 9s - loss: 0.8959 - acc: 0.5550
- recall: 0.5683 - precision: 0.7315Epoch 28/45
36/75 [=============>................] - ETA: 1s - loss: 0.8015 - acc: 0.5722
- recall: 0.6405 - precision: 0.7277Epoch 31/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9329 - acc: 0.
5189 - recall: 0.5581 - precision: 0.7121
 1/75 [..............................] - ETA: 5s - loss: 0.7720 - acc: 0.7200
- recall: 0.8310 - precision: 0.7867Epoch 31/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7386 - acc: 0.
4992 - recall: 0.4889 - precision: 0.7224
Epoch 31/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9791 - acc: 0.
5415 - recall: 0.5859 - precision: 0.7218
18/75 [======>.......................] - ETA: 1s - loss: 0.8031 - acc: 0.5711
- recall: 0.6426 - precision: 0.7272Epoch 28/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7896 - acc: 0.
5724 - recall: 0.6368 - precision: 0.7361
Epoch 29/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8055 - acc: 0.
5638 - recall: 0.6287 - precision: 0.7258
Epoch 29/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7321 - acc: 0.
5287 - recall: 0.5363 - precision: 0.7381
Epoch 29/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7587 - acc: 0.
4979 - recall: 0.4719 - precision: 0.7367
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 5/75 [=>............................] - ETA: 4s - loss: 0.7548 - acc: 0.5860
- recall: 0.6366 - precision: 0.7590Epoch 29/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7758 - acc: 0.
4436 - recall: 0.4033 - precision: 0.6916
 8/75 [==>...........................] - ETA: 2s - loss: 0.7549 - acc: 0.5938
- recall: 0.6436 - precision: 0.7697Epoch 31/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7252 - acc: 0.
5168 - recall: 0.5154 - precision: 0.7371
Epoch 29/45
75/75 [==============================] - 2s 24ms/step - loss: 0.8092 - acc: 0.
5604 - recall: 0.6346 - precision: 0.7218
Epoch 32/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7729 - acc: 0.
4763 - recall: 0.4586 - precision: 0.7147
10/75 [===>..........................] - ETA: 1s - loss: 0.7368 - acc: 0.5320
- recall: 0.5330 - precision: 0.7379Epoch 29/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9248 - acc: 0.
5320 - recall: 0.5711 - precision: 0.7233
Epoch 30/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7445 - acc: 0.
4908 - recall: 0.4804 - precision: 0.7155
Epoch 32/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9263 - acc: 0.
5179 - recall: 0.5491 - precision: 0.7157
43/75 [================>.............] - ETA: 0s - loss: 0.8098 - acc: 0.5642
- recall: 0.6295 - precision: 0.7252Epoch 32/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9472 - acc: 0.
5407 - recall: 0.5727 - precision: 0.7282
54/75 [====================>.........] - ETA: 0s - loss: 0.8121 - acc: 0.5622
- recall: 0.6289 - precision: 0.7236Epoch 29/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8088 - acc: 0.
5622 - recall: 0.6289 - precision: 0.7238
Epoch 30/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7972 - acc: 0.
5690 - recall: 0.6330 - precision: 0.7342
56/75 [=====================>........] - ETA: 0s - loss: 0.7659 - acc: 0.4891
- recall: 0.4666 - precision: 0.7283Epoch 30/45
75/75 [==============================] - 2s 24ms/step - loss: 0.7788 - acc: 0.
4358 - recall: 0.3984 - precision: 0.6820
Epoch 32/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7269 - acc: 0.
5343 - recall: 0.5392 - precision: 0.7441
39/75 [==============>...............] - ETA: 1s - loss: 0.9299 - acc: 0.5172
- recall: 0.5528 - precision: 0.7054Epoch 30/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7620 - acc: 0.
4900 - recall: 0.4689 - precision: 0.7264
Epoch 30/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8042 - acc: 0.
5564 - recall: 0.6305 - precision: 0.7193
60/75 [=======================>......] - ETA: 0s - loss: 0.8922 - acc: 0.5468
- recall: 0.5811 - precision: 0.7368Epoch 33/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7288 - acc: 0.
5221 - recall: 0.5204 - precision: 0.7415
67/75 [=========================>....] - ETA: 0s - loss: 0.7593 - acc: 0.4855
- recall: 0.4681 - precision: 0.7218Epoch 30/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7278 - acc: 0.
5031 - recall: 0.4852 - precision: 0.7308
Epoch 33/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9140 - acc: 0.
5261 - recall: 0.5598 - precision: 0.7203
```

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Epoch 33/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7619 - acc: 0.
4845 - recall: 0.4678 - precision: 0.7212
Epoch 30/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9001 - acc: 0.
5464 - recall: 0.5809 - precision: 0.7360
Epoch 31/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9653 - acc: 0.
5422 - recall: 0.5777 - precision: 0.7272
Epoch 30/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8019 - acc: 0.
5622 - recall: 0.6265 - precision: 0.7251
35/75 [=============>.............] - ETA: 1s - loss: 0.7366 - acc: 0.4943
- recall: 0.4778 - precision: 0.7185Epoch 31/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7681 - acc: 0.
4534 - recall: 0.4102 - precision: 0.7034
71/75 [===========================>..] - ETA: 0s - loss: 0.8019 - acc: 0.5745
- recall: 0.6397 - precision: 0.7361Epoch 33/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7294 - acc: 0.
5303 - recall: 0.5326 - precision: 0.7428
Epoch 31/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7975 - acc: 0.
5758 - recall: 0.6389 - precision: 0.7390
Epoch 31/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7521 - acc: 0.
4972 - recall: 0.4704 - precision: 0.7367
49/75 [==================>...........] - ETA: 0s - loss: 0.7595 - acc: 0.4849
- recall: 0.4752 - precision: 0.7181Epoch 31/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8063 - acc: 0.
5568 - recall: 0.6288 - precision: 0.7206
34/75 [============>.................] - ETA: 1s - loss: 0.9486 - acc: 0.5297
- recall: 0.5711 - precision: 0.7141Epoch 34/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7197 - acc: 0.
5277 - recall: 0.5206 - precision: 0.7497
Epoch 31/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9207 - acc: 0.
5115 - recall: 0.5433 - precision: 0.7107
27/75 [=========>....................] - ETA: 2s - loss: 0.7253 - acc: 0.5263
- recall: 0.5267 - precision: 0.7411Epoch 34/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7296 - acc: 0.
4979 - recall: 0.4835 - precision: 0.7240
17/75 [=====>........................] - ETA: 1s - loss: 0.8104 - acc: 0.5588
- recall: 0.6294 - precision: 0.7192Epoch 34/45
75/75 [==============================] - 2s 31ms/step - loss: 0.8918 - acc: 0.
5436 - recall: 0.5809 - precision: 0.7324
Epoch 32/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7597 - acc: 0.
4869 - recall: 0.4748 - precision: 0.7201
Epoch 31/45
75/75 [==============================] - 2s 31ms/step - loss: 0.9421 - acc: 0.
5366 - recall: 0.5757 - precision: 0.7213
56/75 [=====================>........] - ETA: 0s - loss: 0.8020 - acc: 0.5702
- recall: 0.6337 - precision: 0.7328Epoch 31/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8075 - acc: 0.
5556 - recall: 0.6178 - precision: 0.7219
Epoch 32/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7713 - acc: 0.
4373 - recall: 0.3964 - precision: 0.6857
39/75 [==============>...............] - ETA: 0s - loss: 0.9264 - acc: 0.5179
- recall: 0.5455 - precision: 0.7162Epoch 34/45
```

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75/75 [==============================] - 2s 33ms/step - loss: 0.7959 - acc: 0.
5726 - recall: 0.6357 - precision: 0.7369
 8/75 [==>...........................] - ETA: 2s - loss: 0.7750 - acc: 0.4562
- recall: 0.4162 - precision: 0.6941Epoch 32/45
75/75 [==============================] - 3s 35ms/step - loss: 0.7289 - acc: 0.
5221 - recall: 0.5241 - precision: 0.7369
56/75 [=====================>........] - ETA: 0s - loss: 0.9346 - acc: 0.5193
- recall: 0.5508 - precision: 0.7146Epoch 32/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7519 - acc: 0.
4940 - recall: 0.4632 - precision: 0.7370
Epoch 32/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8032 - acc: 0.
5636 - recall: 0.6401 - precision: 0.7227
Epoch 35/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9273 - acc: 0.
5188 - recall: 0.5483 - precision: 0.7174
65/75 [=========================>....] - ETA: 0s - loss: 0.9150 - acc: 0.5412
- recall: 0.5763 - precision: 0.7324Epoch 35/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7352 - acc: 0.
4972 - recall: 0.4818 - precision: 0.7241
Epoch 35/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7264 - acc: 0.
5149 - recall: 0.5054 - precision: 0.7413
41/75 [===============>..............] - ETA: 0s - loss: 0.7941 - acc: 0.5605
- recall: 0.6142 - precision: 0.7318Epoch 32/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9137 - acc: 0.
5406 - recall: 0.5778 - precision: 0.7303
 7/75 [=>............................] - ETA: 1s - loss: 0.7511 - acc: 0.5300
- recall: 0.5169 - precision: 0.7072Epoch 33/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7524 - acc: 0.
4828 - recall: 0.4661 - precision: 0.7197
Epoch 32/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9506 - acc: 0.
5444 - recall: 0.5824 - precision: 0.7274
Epoch 32/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7705 - acc: 0.
4382 - recall: 0.3897 - precision: 0.6917
Epoch 35/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8006 - acc: 0.
5674 - recall: 0.6245 - precision: 0.7323
Epoch 33/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7986 - acc: 0.
5718 - recall: 0.6346 - precision: 0.7366
Epoch 33/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7291 - acc: 0.
5253 - recall: 0.5265 - precision: 0.7399
45/75 [=================>............] - ETA: 0s - loss: 0.7553 - acc: 0.4860
- recall: 0.4690 - precision: 0.7234Epoch 33/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8018 - acc: 0.
5642 - recall: 0.6337 - precision: 0.7266
Epoch 36/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7471 - acc: 0.
5100 - recall: 0.4854 - precision: 0.7459
Epoch 33/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9427 - acc: 0.
5152 - recall: 0.5476 - precision: 0.7131
Epoch 36/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7300 - acc: 0.
4961 - recall: 0.4809 - precision: 0.7231
Epoch 36/45
```

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75/75 [==============================] - 2s 28ms/step - loss: 0.9068 - acc: 0.
5446 - recall: 0.5833 - precision: 0.7322
21/75 [=======>......................] - ETA: 1s - loss: 0.7991 - acc: 0.5590
- recall: 0.6186 - precision: 0.7284Epoch 34/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7239 - acc: 0.
5155 - recall: 0.5038 - precision: 0.7433
14/75 [====>.........................] - ETA: 1s - loss: 0.8714 - acc: 0.5171
- recall: 0.5506 - precision: 0.7134Epoch 33/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7636 - acc: 0.
4772 - recall: 0.4626 - precision: 0.7134
Epoch 33/45
75/75 [==============================] - 2s 30ms/step - loss: 0.9469 - acc: 0.
5412 - recall: 0.5761 - precision: 0.7270
45/75 [=================>............] - ETA: 0s - loss: 0.7472 - acc: 0.4918
- recall: 0.4647 - precision: 0.7403Epoch 33/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7569 - acc: 0.
4428 - recall: 0.3951 - precision: 0.6957
Epoch 36/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8000 - acc: 0.
5612 - recall: 0.6233 - precision: 0.7256
Epoch 34/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7935 - acc: 0.
5719 - recall: 0.6355 - precision: 0.7362
52/75 [===================>..........] - ETA: 0s - loss: 0.9085 - acc: 0.5029
- recall: 0.5350 - precision: 0.7076Epoch 34/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7263 - acc: 0.
5259 - recall: 0.5243 - precision: 0.7421
 1/75 [..............................] - ETA: 9s - loss: 0.7546 - acc: 0.5700
- recall: 0.5921 - precision: 0.7895Epoch 34/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7478 - acc: 0.
5007 - recall: 0.4706 - precision: 0.7422
62/75 [=======================>......] - ETA: 0s - loss: 0.7342 - acc: 0.4873
- recall: 0.4653 - precision: 0.7216Epoch 34/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7931 - acc: 0.
5676 - recall: 0.6337 - precision: 0.7306
59/75 [======================>.......] - ETA: 0s - loss: 0.8865 - acc: 0.5453
- recall: 0.5791 - precision: 0.7349Epoch 37/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9162 - acc: 0.
5072 - recall: 0.5383 - precision: 0.7079
Epoch 37/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7349 - acc: 0.
4871 - recall: 0.4647 - precision: 0.7201
27/75 [=========>....................] - ETA: 1s - loss: 0.7836 - acc: 0.5804
- recall: 0.6476 - precision: 0.7418Epoch 37/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9004 - acc: 0.
5448 - recall: 0.5815 - precision: 0.7336
48/75 [==================>...........] - ETA: 0s - loss: 0.7585 - acc: 0.4533
- recall: 0.4068 - precision: 0.7014Epoch 35/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7582 - acc: 0.
4795 - recall: 0.4637 - precision: 0.7162
Epoch 34/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7245 - acc: 0.
5175 - recall: 0.5121 - precision: 0.7404
Epoch 34/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9513 - acc: 0.
5355 - recall: 0.5677 - precision: 0.7244
Epoch 34/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7544 - acc: 0.
4509 - recall: 0.4036 - precision: 0.7037
26/75 [=========>....................] - ETA: 1s - loss: 0.9233 - acc: 0.5292
```

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- recall: 0.5743 - precision: 0.7129Epoch 37/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8066 - acc: 0.
5554 - recall: 0.6161 - precision: 0.7225
Epoch 35/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7938 - acc: 0.
5654 - recall: 0.6289 - precision: 0.7321
Epoch 35/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7484 - acc: 0.
4904 - recall: 0.4604 - precision: 0.7332
Epoch 35/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7182 - acc: 0.
5403 - recall: 0.5424 - precision: 0.7505
Epoch 35/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7909 - acc: 0.
5668 - recall: 0.6338 - precision: 0.7296
 4/75 [>.............................] - ETA: 4s - loss: 0.7599 - acc: 0.4625
- recall: 0.4345 - precision: 0.7119Epoch 38/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9021 - acc: 0.
5271 - recall: 0.5578 - precision: 0.7227
35/75 [=============>................] - ETA: 1s - loss: 0.7524 - acc: 0.4466
- recall: 0.3990 - precision: 0.7026Epoch 38/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7299 - acc: 0.
4967 - recall: 0.4750 - precision: 0.7280
Epoch 38/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7178 - acc: 0.
5189 - recall: 0.5093 - precision: 0.7445
Epoch 35/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9047 - acc: 0.
5338 - recall: 0.5728 - precision: 0.7246
Epoch 36/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7507 - acc: 0.
4929 - recall: 0.4750 - precision: 0.7292
Epoch 35/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7604 - acc: 0.
4404 - recall: 0.3943 - precision: 0.6922
47/75 [=================>............] - ETA: 0s - loss: 0.7499 - acc: 0.4917
- recall: 0.4589 - precision: 0.7374Epoch 38/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9378 - acc: 0.
5452 - recall: 0.5783 - precision: 0.7308
Epoch 35/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7972 - acc: 0.
5651 - recall: 0.6276 - precision: 0.7279
51/75 [===================>..........] - ETA: 0s - loss: 0.8985 - acc: 0.5188
- recall: 0.5453 - precision: 0.7209Epoch 36/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7999 - acc: 0.
5694 - recall: 0.6352 - precision: 0.7334
Epoch 36/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7999 - acc: 0.
5560 - recall: 0.6264 - precision: 0.7209
65/75 [=========================>....] - ETA: 0s - loss: 0.9119 - acc: 0.5200
- recall: 0.5485 - precision: 0.7197Epoch 39/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7541 - acc: 0.
4877 - recall: 0.4552 - precision: 0.7327
Epoch 36/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7174 - acc: 0.
5322 - recall: 0.5278 - precision: 0.7489
Epoch 36/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7281 - acc: 0.
4939 - recall: 0.4727 - precision: 0.7252
33/75 [============>.................] - ETA: 1s - loss: 0.7672 - acc: 0.4430
```

```
- recall: 0.3878 - precision: 0.6875Epoch 39/45
75/75 [==============================] - 3s 32ms/step - loss: 0.9166 - acc: 0.
5185 - recall: 0.5476 - precision: 0.7174
27/75 [=========>....................] - ETA: 1s - loss: 0.8055 - acc: 0.5548
- recall: 0.6084 - precision: 0.7319Epoch 39/45
75/75 [==============================] - 2s 30ms/step - loss: 0.8860 - acc: 0.
5364 - recall: 0.5702 - precision: 0.7295
Epoch 37/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7139 - acc: 0.
5297 - recall: 0.5208 - precision: 0.7525
Epoch 36/45
75/75 [==============================] - 2s 33ms/step - loss: 0.7510 - acc: 0.
4851 - recall: 0.4645 - precision: 0.7243
10/75 [===>..........................] - ETA: 1s - loss: 0.9524 - acc: 0.5550
- recall: 0.5903 - precision: 0.7391Epoch 36/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7644 - acc: 0.
4338 - recall: 0.3821 - precision: 0.6893
38/75 [==============>...............] - ETA: 0s - loss: 0.9161 - acc: 0.5097
- recall: 0.5297 - precision: 0.7105Epoch 39/45
75/75 [==============================] - 2s 33ms/step - loss: 0.9368 - acc: 0.
5448 - recall: 0.5796 - precision: 0.7296
34/75 [============>.................] - ETA: 1s - loss: 0.9011 - acc: 0.5459
- recall: 0.5856 - precision: 0.7396Epoch 36/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8014 - acc: 0.
5607 - recall: 0.6166 - precision: 0.7286
Epoch 37/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8025 - acc: 0.
5703 - recall: 0.6344 - precision: 0.7349
Epoch 37/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7905 - acc: 0.
5636 - recall: 0.6324 - precision: 0.7267
Epoch 40/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7467 - acc: 0.
4868 - recall: 0.4561 - precision: 0.7305
25/75 [=========>....................] - ETA: 1s - loss: 0.7526 - acc: 0.4396
- recall: 0.3821 - precision: 0.6987Epoch 37/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7338 - acc: 0.
4895 - recall: 0.4718 - precision: 0.7191
Epoch 40/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7252 - acc: 0.
5225 - recall: 0.5230 - precision: 0.7382
16/75 [=====>........................] - ETA: 1s - loss: 0.7978 - acc: 0.5744
- recall: 0.6328 - precision: 0.7434Epoch 37/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9174 - acc: 0.
5160 - recall: 0.5435 - precision: 0.7164
56/75 [=====================>........] - ETA: 0s - loss: 0.7544 - acc: 0.4787
- recall: 0.4563 - precision: 0.7197Epoch 40/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9046 - acc: 0.
5454 - recall: 0.5752 - precision: 0.7381
30/75 [===========>..................] - ETA: 1s - loss: 0.8041 - acc: 0.5743
- recall: 0.6350 - precision: 0.7397Epoch 38/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7191 - acc: 0.
5181 - recall: 0.5117 - precision: 0.7416
52/75 [===================>..........] - ETA: 0s - loss: 0.7595 - acc: 0.4346
- recall: 0.3800 - precision: 0.6921Epoch 37/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7504 - acc: 0.
4811 - recall: 0.4602 - precision: 0.7210
31/75 [===========>..................] - ETA: 0s - loss: 0.7270 - acc: 0.4910
- recall: 0.4679 - precision: 0.7261Epoch 37/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7594 - acc: 0.
```

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4346 - recall: 0.3815 - precision: 0.6911
46/75 [=================>............] - ETA: 0s - loss: 0.7291 - acc: 0.4926
- recall: 0.4727 - precision: 0.7233Epoch 40/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9298 - acc: 0.
5334 - recall: 0.5701 - precision: 0.7203
Epoch 37/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8054 - acc: 0.
5487 - recall: 0.6094 - precision: 0.7181
Epoch 38/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7982 - acc: 0.
5750 - recall: 0.6381 - precision: 0.7384
73/75 [============================>.] - ETA: 0s - loss: 0.7905 - acc: 0.5684
- recall: 0.6352 - precision: 0.7316Epoch 38/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7302 - acc: 0.
4893 - recall: 0.4697 - precision: 0.7202
75/75 [==============================] - 2s 28ms/step - loss: 0.7908 - acc: 0.
5694 - recall: 0.6362 - precision: 0.7313
Epoch 41/45
Epoch 41/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7562 - acc: 0.
4788 - recall: 0.4489 - precision: 0.7228
50/75 [===================>..........] - ETA: 0s - loss: 0.7248 - acc: 0.5190
- recall: 0.5101 - precision: 0.7421Epoch 38/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7220 - acc: 0.
5259 - recall: 0.5241 - precision: 0.7423
Epoch 38/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9038 - acc: 0.
5147 - recall: 0.5431 - precision: 0.7149
Epoch 41/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8990 - acc: 0.
5475 - recall: 0.5807 - precision: 0.7375
Epoch 39/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7229 - acc: 0.
5127 - recall: 0.5040 - precision: 0.7389
Epoch 38/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7462 - acc: 0.
4819 - recall: 0.4584 - precision: 0.7236
Epoch 38/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7573 - acc: 0.
4352 - recall: 0.3854 - precision: 0.6893
Epoch 41/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9345 - acc: 0.
5348 - recall: 0.5694 - precision: 0.7226
43/75 [================>.............] - ETA: 0s - loss: 0.9179 - acc: 0.5156
- recall: 0.5482 - precision: 0.7177Epoch 38/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7930 - acc: 0.
5695 - recall: 0.6296 - precision: 0.7366
17/75 [=====>........................] - ETA: 1s - loss: 0.7492 - acc: 0.4253
- recall: 0.3706 - precision: 0.6813Epoch 39/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7987 - acc: 0.
5531 - recall: 0.6107 - precision: 0.7226
12/75 [===>..........................] - ETA: 1s - loss: 0.9748 - acc: 0.5292
- recall: 0.5676 - precision: 0.7151Epoch 39/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7372 - acc: 0.
4997 - recall: 0.4659 - precision: 0.7442
Epoch 39/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7308 - acc: 0.
4885 - recall: 0.4664 - precision: 0.7213
 5/75 [=>............................] - ETA: 2s - loss: 0.8123 - acc: 0.5680
- recall: 0.6317 - precision: 0.7217Epoch 42/45
```

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75/75 [==============================] - 2s 29ms/step - loss: 0.7207 - acc: 0.
5171 - recall: 0.5137 - precision: 0.7365
 9/75 [==>...........................] - ETA: 0s - loss: 0.7279 - acc: 0.5267
- recall: 0.5127 - precision: 0.7330Epoch 39/45
75/75 [==============================] - 2s 25ms/step - loss: 0.9191 - acc: 0.
5137 - recall: 0.5437 - precision: 0.7134
74/75 [============================>.] - ETA: 0s - loss: 0.7919 - acc: 0.5550
- recall: 0.6191 - precision: 0.7242Epoch 42/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7929 - acc: 0.
5554 - recall: 0.6200 - precision: 0.7235
36/75 [=============>................] - ETA: 1s - loss: 0.7555 - acc: 0.4381
- recall: 0.3864 - precision: 0.6969Epoch 42/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7113 - acc: 0.
5259 - recall: 0.5163 - precision: 0.7499
31/75 [===========>..................] - ETA: 1s - loss: 0.7957 - acc: 0.5542
- recall: 0.6031 - precision: 0.7314Epoch 39/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8612 - acc: 0.
5414 - recall: 0.5728 - precision: 0.7343
Epoch 40/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7590 - acc: 0.
4685 - recall: 0.4506 - precision: 0.7080
Epoch 39/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7573 - acc: 0.
4342 - recall: 0.3811 - precision: 0.6906
Epoch 42/45
75/75 [==============================] - 2s 28ms/step - loss: 0.9446 - acc: 0.
5303 - recall: 0.5604 - precision: 0.7218
Epoch 39/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7896 - acc: 0.
5782 - recall: 0.6366 - precision: 0.7431
59/75 [======================>.......] - ETA: 0s - loss: 0.9211 - acc: 0.5110
- recall: 0.5389 - precision: 0.7160Epoch 40/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7976 - acc: 0.
5544 - recall: 0.6103 - precision: 0.7244
Epoch 40/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7405 - acc: 0.
4959 - recall: 0.4639 - precision: 0.7395
44/75 [================>.............] - ETA: 0s - loss: 0.7422 - acc: 0.4823
- recall: 0.4649 - precision: 0.7230Epoch 40/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7297 - acc: 0.
4981 - recall: 0.4833 - precision: 0.7245
Epoch 43/45
75/75 [==============================] - 2s 24ms/step - loss: 0.7943 - acc: 0.
5595 - recall: 0.6281 - precision: 0.7241
16/75 [=====>........................] - ETA: 1s - loss: 0.9296 - acc: 0.5362
- recall: 0.5703 - precision: 0.7376Epoch 43/45
75/75 [==============================] - 2s 27ms/step - loss: 0.9191 - acc: 0.
5131 - recall: 0.5379 - precision: 0.7158
13/75 [====>.........................] - ETA: 1s - loss: 0.8422 - acc: 0.5492
- recall: 0.6039 - precision: 0.7143Epoch 43/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7164 - acc: 0.
5243 - recall: 0.5165 - precision: 0.7452
Epoch 40/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7114 - acc: 0.
5207 - recall: 0.5123 - precision: 0.7450
Epoch 40/45
75/75 [==============================] - 2s 29ms/step - loss: 0.8777 - acc: 0.
5388 - recall: 0.5691 - precision: 0.7332
Epoch 41/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7433 - acc: 0.
```

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4816 - recall: 0.4580 - precision: 0.7234
 2/75 [..............................] - ETA: 9s - loss: 0.6922 - acc: 0.5300
- recall: 0.5102 - precision: 0.7732Epoch 40/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7530 - acc: 0.
4364 - recall: 0.3835 - precision: 0.6927
55/75 [=====================>........] - ETA: 0s - loss: 0.7974 - acc: 0.5482
- recall: 0.6041 - precision: 0.7212Epoch 43/45
75/75 [==============================] - 2s 33ms/step - loss: 0.9427 - acc: 0.
5366 - recall: 0.5714 - precision: 0.7237
75/75 [==============================] - 2s 30ms/step - loss: 0.7978 - acc: 0.
5534 - recall: 0.6103 - precision: 0.7231
67/75 [=========================>....] - ETA: 0s - loss: 0.7199 - acc: 0.4961
- recall: 0.4713 - precision: 0.7328Epoch 41/45
35/75 [============>.................] - ETA: 1s - loss: 0.8920 - acc: 0.5323
- recall: 0.5648 - precision: 0.7344Epoch 40/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7222 - acc: 0.
4956 - recall: 0.4707 - precision: 0.7294
37/75 [=============>................] - ETA: 1s - loss: 0.7421 - acc: 0.4951
- recall: 0.4738 - precision: 0.7264Epoch 44/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7436 - acc: 0.
4896 - recall: 0.4583 - precision: 0.7334
72/75 [===========================>..] - ETA: 0s - loss: 0.8970 - acc: 0.5107
- recall: 0.5359 - precision: 0.7141Epoch 41/45
75/75 [==============================] - 3s 33ms/step - loss: 0.7954 - acc: 0.
5686 - recall: 0.6269 - precision: 0.7370
Epoch 41/45
75/75 [==============================] - 2s 28ms/step - loss: 0.8977 - acc: 0.
5131 - recall: 0.5385 - precision: 0.7154
Epoch 44/45
75/75 [==============================] - 2s 31ms/step - loss: 0.7949 - acc: 0.
5548 - recall: 0.6218 - precision: 0.7219
Epoch 44/45
75/75 [==============================] - 2s 32ms/step - loss: 0.7132 - acc: 0.
5340 - recall: 0.5318 - precision: 0.7488
Epoch 41/45
75/75 [==============================] - 2s 32ms/step - loss: 0.8883 - acc: 0.
5344 - recall: 0.5665 - precision: 0.7290
73/75 [============================>.] - ETA: 0s - loss: 0.7347 - acc: 0.4870
- recall: 0.4644 - precision: 0.7290Epoch 42/45
75/75 [==============================] - 2s 23ms/step - loss: 0.7511 - acc: 0.
4337 - recall: 0.3768 - precision: 0.6927
75/75 [==============================] - 2s 31ms/step - loss: 0.7360 - acc: 0.
4876 - recall: 0.4652 - precision: 0.7278
Epoch 41/45
Epoch 44/45
75/75 [==============================] - 3s 34ms/step - loss: 0.7122 - acc: 0.
5195 - recall: 0.5082 - precision: 0.7461
Epoch 41/45
75/75 [==============================] - 2s 24ms/step - loss: 0.7187 - acc: 0.
4943 - recall: 0.4735 - precision: 0.7253
64/75 [========================>.....] - ETA: 0s - loss: 0.9429 - acc: 0.5333
- recall: 0.5709 - precision: 0.7202Epoch 45/45
75/75 [==============================] - 2s 29ms/step - loss: 0.9405 - acc: 0.
5316 - recall: 0.5692 - precision: 0.7186
37/75 [=============>................] - ETA: 1s - loss: 0.7094 - acc: 0.5186
- recall: 0.5052 - precision: 0.7496Epoch 41/45
75/75 [==============================] - 2s 30ms/step - loss: 0.7966 - acc: 0.
5592 - recall: 0.6153 - precision: 0.7275
70/75 [===========================>..] - ETA: 0s - loss: 0.7963 - acc: 0.5770
- recall: 0.6355 - precision: 0.7416Epoch 42/45
```

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75/75 [==============================] - 2s 28ms/step - loss: 0.8977 - acc: 0.
5149 - recall: 0.5409 - precision: 0.7165
75/75 [==============================] - 2s 27ms/step - loss: 0.7891 - acc: 0.
5587 - recall: 0.6207 - precision: 0.7270
Epoch 45/45
Epoch 45/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7910 - acc: 0.
5759 - recall: 0.6341 - precision: 0.7418
 5/75 [=>............................] - ETA: 2s - loss: 0.7476 - acc: 0.5640
- recall: 0.6168 - precision: 0.7467Epoch 42/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7389 - acc: 0.
4829 - recall: 0.4421 - precision: 0.7348
 1/75 [..............................] - ETA: 2s - loss: 0.8374 - acc: 0.5300
- recall: 0.6143 - precision: 0.6825Epoch 42/45
75/75 [==============================] - 2s 29ms/step - loss: 0.7162 - acc: 0.
5215 - recall: 0.5163 - precision: 0.7412
11/75 [===>..........................] - ETA: 1s - loss: 0.8494 - acc: 0.5536
- recall: 0.6405 - precision: 0.6941Epoch 42/45
75/75 [==============================] - 2s 24ms/step - loss: 0.8906 - acc: 0.
5386 - recall: 0.5724 - precision: 0.7309
25/75 [=========>....................] - ETA: 1s - loss: 0.9183 - acc: 0.5360
- recall: 0.5660 - precision: 0.7296Epoch 43/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7414 - acc: 0.
4765 - recall: 0.4549 - precision: 0.7176
Epoch 42/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7148 - acc: 0.
5120 - recall: 0.4997 - precision: 0.7409
75/75 [==============================] - 2s 28ms/step - loss: 0.7476 - acc: 0.
4306 - recall: 0.3726 - precision: 0.6902
Epoch 42/45
Epoch 45/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7276 - acc: 0.
4823 - recall: 0.4549 - precision: 0.7194
58/75 [======================>.......] - ETA: 0s - loss: 0.9234 - acc: 0.5033
- recall: 0.5266 - precision: 0.7083
2023-04-06 04:15:51.144403: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
75/75 [==============================] - 2s 28ms/step - loss: 0.9210 - acc: 0.
5386 - recall: 0.5712 - precision: 0.7263
57/75 [=====================>........] - ETA: 0s - loss: 0.7117 - acc: 0.5316
- recall: 0.5226 - precision: 0.7506Epoch 42/45
75/75 [==============================] - 2s 27ms/step - loss: 0.7866 - acc: 0.
5610 - recall: 0.6279 - precision: 0.7259
75/75 [==============================] - 2s 27ms/step - loss: 0.9216 - acc: 0.
5064 - recall: 0.5333 - precision: 0.7096
118/118 [==============================] - 1s 4ms/steps: 0.7342 - acc: 0.4851
- recall: 0.4510 - precision: 0.72
75/75 [==============================] - 2s 29ms/step - loss: 0.7910 - acc: 0.
5583 - recall: 0.6140 - precision: 0.7271
42/75 [===============>..............] - ETA: 0s - loss: 0.7088 - acc: 0.5212
- recall: 0.5112 - precision: 0.7451Epoch 43/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7931 - acc: 0.
5626 - recall: 0.6204 - precision: 0.7334
Epoch 43/45
59/75 [======================>.......] - ETA: 0s - loss: 0.8817 - acc: 0.5403
- recall: 0.5729 - precision: 0.7324
```

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2023-04-06 04:15:51.646354: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:15:51.676701: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
75/75 [==============================] - 2s 31ms/step - loss: 0.7329 - acc: 0.
4843 - recall: 0.4489 - precision: 0.7317
 51/235 [=====>........................] - ETA: 0sEpoch 43/45
75/75 [==============================] - 2s 28ms/step - loss: 0.7114 - acc: 0.
5292 - recall: 0.5178 - precision: 0.7517
18/75 [======>.......................] - ETA: 1s - loss: 0.9469 - acc: 0.5306
- recall: 0.5670 - precision: 0.7223Epoch 43/45
75/75 [==============================] - 2s 27ms/step - loss: 0.8897 - acc: 0.
5370 - recall: 0.5719 - precision: 0.7292
118/118 [==============================] - 1s 4ms/steps: 0.7062 - acc: 0.5216
- recall: 0.5089 - precision: 0.75
67/75 [=========================>....] - ETA: 0s - loss: 0.7386 - acc: 0.4824
- recall: 0.4558 - precision: 0.7282Epoch 44/45
118/118 [==============================] - 1s 4ms/steps: 0.7570 - acc: 0.4440
- recall: 0.4130 - precision: 0.7172
75/75 [==============================] - 2s 26ms/step - loss: 0.7405 - acc: 0.
4831 - recall: 0.4575 - precision: 0.7261
Epoch 43/45
75/75 [==============================] - 2s 25ms/step - loss: 0.7480 - acc: 0.
4308 - recall: 0.3707 - precision: 0.6918
75/75 [==============================] - 2s 28ms/step - loss: 0.7091 - acc: 0.
5223 - recall: 0.5101 - precision: 0.7491
Epoch 43/45
129/235 [===============>..............] - ETA: 0s loss: 0.9365 - acc: 0.5315
- recall: 0.5607 - precision: 0.72
2023-04-06 04:15:52.449981: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

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235/235 [==============================] - 1s 4ms/steps: 0.9385 - acc: 0.5340
- recall: 0.5636 - precision: 0.72
42/75 [===============>.............] - ETA: 0s - loss: 0.7958 - acc: 0.5655
- recall: 0.6241 - precision: 0.7360
systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

118/118 [==============================] - 0s 4ms/steps: 0.7421 - acc: 0.4731
- recall: 0.4345 - precision: 0.72
235/235 [==============================] - 1s 3ms/steps: 0.7310 - acc: 0.5213
- recall: 0.5022 - precision: 0.7380
235/235 [==============================] - 1s 4ms/steps: 0.7882 - acc: 0.5661
- recall: 0.6225 - precision: 0.73
36/75 [=============>................] - ETA: 1s - loss: 0.7336 - acc: 0.4678
- recall: 0.4419 - precision: 0.7230
systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

75/75 [==============================] - 2s 23ms/step - loss: 0.7914 - acc: 0.
5684 - recall: 0.6256 - precision: 0.7376
69/75 [==========================>...] - ETA: 0s - loss: 0.9329 - acc: 0.5358
- recall: 0.5681 - precision: 0.7248Epoch 44/45
75/75 [==============================] - 2s 26ms/step - loss: 0.9372 - acc: 0.
5367 - recall: 0.5701 - precision: 0.7246
Epoch 43/45
75/75 [==============================] - 2s 26ms/step - loss: 0.7988 - acc: 0.
5578 - recall: 0.6178 - precision: 0.7245
Epoch 44/45
75/75 [==============================] - 2s 23ms/step - loss: 0.7403 - acc: 0.
4844 - recall: 0.4498 - precision: 0.7313
Epoch 44/45
235/235 [==============================] - 1s 4ms/steps: 0.7449 - acc: 0.4800
- recall: 0.4289 - precision: 0.7300

systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

75/75 [==============================] - 2s 25ms/step - loss: 0.7140 - acc: 0.
5264 - recall: 0.5189 - precision: 0.7467
Epoch 44/45
75/75 [==============================] - 2s 25ms/step - loss: 0.8930 - acc: 0.
5371 - recall: 0.5682 - precision: 0.7315
Epoch 45/45
75/75 [==============================] - 2s 23ms/step - loss: 0.7379 - acc: 0.
4756 - recall: 0.4519 - precision: 0.7182
Epoch 44/45
75/75 [==============================] - 2s 23ms/step - loss: 0.7114 - acc: 0.
5205 - recall: 0.5082 - precision: 0.7478
Epoch 44/45
 4/75 [>.............................] - ETA: 1s - loss: 0.7287 - acc: 0.5025
- recall: 0.4876 - precision: 0.7188
systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

75/75 [==============================] - 2s 21ms/step - loss: 0.7916 - acc: 0.
5656 - recall: 0.6261 - precision: 0.7339
48/75 [==================>...........] - ETA: 0s - loss: 0.8830 - acc: 0.5406
- recall: 0.5718 - precision: 0.7324Epoch 45/45
75/75 [==============================] - 2s 21ms/step - loss: 0.8032 - acc: 0.
5466 - recall: 0.6060 - precision: 0.7173
```

```
11/75 [===>..........................] - ETA: 1s - loss: 0.7649 - acc: 0.5791
- recall: 0.6398 - precision: 0.7572Epoch 45/45
75/75 [==============================] - 2s 23ms/step - loss: 0.9407 - acc: 0.
5328 - recall: 0.5667 - precision: 0.7215
Epoch 44/45
75/75 [==============================] - 2s 22ms/step - loss: 0.7352 - acc: 0.
4852 - recall: 0.4454 - precision: 0.7360
Epoch 45/45
75/75 [==============================] - 2s 20ms/step - loss: 0.7108 - acc: 0.
5173 - recall: 0.5072 - precision: 0.7413
Epoch 45/45
75/75 [==============================] - 2s 20ms/step - loss: 0.8821 - acc: 0.
5412 - recall: 0.5724 - precision: 0.7344
75/75 [==============================] - 2s 20ms/step - loss: 0.7324 - acc: 0.
4920 - recall: 0.4637 - precision: 0.7359
Epoch 45/45
29/75 [==========>...................] - ETA: 0s - loss: 0.7760 - acc: 0.5631
- recall: 0.6045 - precision: 0.7418
2023-04-06 04:15:55.586909: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
75/75 [==============================] - 2s 20ms/step - loss: 0.7111 - acc: 0.
5177 - recall: 0.5047 - precision: 0.7460
24/75 [========>.....................] - ETA: 1s - loss: 0.7399 - acc: 0.4904
- recall: 0.4575 - precision: 0.7361Epoch 45/45
118/118 [==============================] - 1s 7ms/steps: 0.7093 - acc: 0.5248
- recall: 0.5103 - precision: 0.75
75/75 [==============================] - 2s 20ms/step - loss: 0.7862 - acc: 0.
5715 - recall: 0.6302 - precision: 0.7387
75/75 [==============================] - 1s 18ms/step - loss: 0.9432 - acc: 0.
5383 - recall: 0.5727 - precision: 0.7251
Epoch 45/45
75/75 [==============================] - 1s 19ms/step - loss: 0.7902 - acc: 0.
5610 - recall: 0.6109 - precision: 0.7320
2023-04-06 04:15:56.568386: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
48/75 [==================>...........] - ETA: 0s - loss: 0.7130 - acc: 0.5210
- recall: 0.5088 - precision: 0.7462
2023-04-06 04:15:56.964043: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:15:57.062039: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:15:57.102981: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
75/75 [==============================] - 2s 22ms/step - loss: 0.7070 - acc: 0.
5352 - recall: 0.5243 - precision: 0.7560
75/75 [==============================] - 2s 23ms/step - loss: 0.7353 - acc: 0.
4863 - recall: 0.4532 - precision: 0.7318
75/75 [==============================] - 2s 21ms/step - loss: 0.7421 - acc: 0.
4776 - recall: 0.4569 - precision: 0.7179
75/75 [==============================] - 1s 20ms/step - loss: 0.7109 - acc: 0.
5247 - recall: 0.5117 - precision: 0.7515
118/118 [==============================] - 1s 7ms/steps: 0.9322 - acc: 0.5403
- recall: 0.5728 - precision: 0.72
118/118 [==============================] - 1s 3ms/steps: 0.9333 - acc: 0.5383
- recall: 0.5704 - precision: 0.72
2023-04-06 04:15:57.220037: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
2023-04-06 04:15:57.329878: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
118/118 [==============================] - 0s 3ms/steps: 0.9346 - acc: 0.5357
- recall: 0.5680 - precision: 0.72
118/118 [==============================] - 0s 3ms/step
118/118 [==============================] - 0s 3ms/steps: 0.9400 - acc: 0.5341
- recall: 0.5680 - precision: 0.72
235/235 [==============================] - 1s 3ms/steps: 0.9423 - acc: 0.5318
- recall: 0.5636 - precision: 0.72
118/118 [==============================] - 0s 2ms/step
70/75 [===========================>..] - ETA: 0s - loss: 0.9369 - acc: 0.5337
- recall: 0.5632 - precision: 0.7253
systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

75/75 [==============================] - 1s 17ms/step - loss: 0.9346 - acc: 0.
5358 - recall: 0.5654 - precision: 0.7260
235/235 [==============================] - 1s 2ms/step
235/235 [==============================] - 1s 2ms/step
235/235 [==============================] - 1s 2ms/step
2023-04-06 04:15:57.836236: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
235/235 [==============================] - 1s 2ms/step
235/235 [==============================] - 0s 2ms/step
118/118 [==============================] - 0s 2ms/step
235/235 [==============================] - 0s 2ms/step
 34/235 [===>..........................] - ETA: 0s
systemMemory: 64.00 GB
maxCacheSize: 24.00 GB

235/235 [==============================] - 0s 1ms/step

systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


systemMemory: 64.00 GB
maxCacheSize: 24.00 GB


Epoch 1/45
  1/113 [..............................] - ETA: 48s - loss: 0.9688 - acc: 0.50
00 - recall: 0.5972 - precision: 0.6719
2023-04-06 04:16:00.398379: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
113/113 [==============================] - 1s 9ms/step - loss: 0.8920 - acc:
0.5471 - recall: 0.6183 - precision: 0.7143
Epoch 2/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8883 - acc:
0.5438 - recall: 0.6143 - precision: 0.7125
Epoch 3/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8954 - acc:
0.5386 - recall: 0.6092 - precision: 0.7090
Epoch 4/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8896 - acc:
0.5442 - recall: 0.6112 - precision: 0.7145
Epoch 5/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8874 - acc:
0.5396 - recall: 0.6093 - precision: 0.7101
Epoch 6/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8857 - acc:
0.5385 - recall: 0.6096 - precision: 0.7087
Epoch 7/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8834 - acc:
0.5402 - recall: 0.6082 - precision: 0.7114
Epoch 8/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8854 - acc:
0.5453 - recall: 0.6149 - precision: 0.7139
Epoch 9/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8720 - acc:
0.5386 - recall: 0.6057 - precision: 0.7107
Epoch 10/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8761 - acc:
0.5453 - recall: 0.6082 - precision: 0.7173
Epoch 11/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8770 - acc:
0.5368 - recall: 0.6030 - precision: 0.7100
Epoch 12/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8697 - acc:
0.5462 - recall: 0.6124 - precision: 0.7162
Epoch 13/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8743 - acc:
0.5403 - recall: 0.6017 - precision: 0.7147
Epoch 14/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8653 - acc:
0.5398 - recall: 0.6060 - precision: 0.7120
Epoch 15/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8789 - acc:
0.5315 - recall: 0.5936 - precision: 0.7084
Epoch 16/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8675 - acc:
0.5394 - recall: 0.6008 - precision: 0.7141
Epoch 17/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8608 - acc:
0.5404 - recall: 0.6019 - precision: 0.7147
Epoch 18/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8622 - acc:
0.5365 - recall: 0.5956 - precision: 0.7133
Epoch 19/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8603 - acc:
0.5343 - recall: 0.5929 - precision: 0.7122
Epoch 20/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8510 - acc:
0.5455 - recall: 0.6056 - precision: 0.7189
Epoch 21/45
```

```
113/113 [==============================] - 1s 8ms/step - loss: 0.8528 - acc:
0.5414 - recall: 0.5983 - precision: 0.7178
Epoch 22/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8524 - acc:
0.5386 - recall: 0.5962 - precision: 0.7155
Epoch 23/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8619 - acc:
0.5307 - recall: 0.5897 - precision: 0.7095
Epoch 24/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8445 - acc:
0.5383 - recall: 0.5952 - precision: 0.7157
Epoch 25/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8565 - acc:
0.5350 - recall: 0.5873 - precision: 0.7159
Epoch 26/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8438 - acc:
0.5390 - recall: 0.5956 - precision: 0.7164
Epoch 27/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8474 - acc:
0.5365 - recall: 0.5898 - precision: 0.7163
Epoch 28/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8397 - acc:
0.5397 - recall: 0.5928 - precision: 0.7186
Epoch 29/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8411 - acc:
0.5423 - recall: 0.5925 - precision: 0.7220
Epoch 30/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8374 - acc:
0.5382 - recall: 0.5902 - precision: 0.7183
Epoch 31/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8417 - acc:
0.5315 - recall: 0.5814 - precision: 0.7147
Epoch 32/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8388 - acc:
0.5353 - recall: 0.5851 - precision: 0.7174
Epoch 33/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8350 - acc:
0.5367 - recall: 0.5854 - precision: 0.7190
Epoch 34/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8397 - acc:
0.5325 - recall: 0.5846 - precision: 0.7142
Epoch 35/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8317 - acc:
0.5290 - recall: 0.5798 - precision: 0.7125
Epoch 36/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8338 - acc:
0.5283 - recall: 0.5765 - precision: 0.7134
Epoch 37/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8375 - acc:
0.5248 - recall: 0.5736 - precision: 0.7106
Epoch 38/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8340 - acc:
0.5296 - recall: 0.5755 - precision: 0.7156
Epoch 39/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8312 - acc:
0.5274 - recall: 0.5746 - precision: 0.7133
Epoch 40/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8218 - acc:
0.5304 - recall: 0.5747 - precision: 0.7169
Epoch 41/45
```

```
113/113 [==============================] - 1s 8ms/step - loss: 0.8279 - acc:
0.5253 - recall: 0.5677 - precision: 0.7143
Epoch 42/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8284 - acc:
0.5311 - recall: 0.5773 - precision: 0.7164
Epoch 43/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8205 - acc:
0.5287 - recall: 0.5721 - precision: 0.7163
Epoch 44/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8249 - acc:
0.5239 - recall: 0.5667 - precision: 0.7132
Epoch 45/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8269 - acc:
0.5224 - recall: 0.5698 - precision: 0.7097
Gridsearch Fit Time: 145.10128784179688
{'dropout_rate': 0.3, 'learning_rate': 0.0001}
```

In [134…

```
print("Best: %f using %s" % (gs_nn.best_score_, gs_nn.best_params_))
```

```
Best: 0.568570 using {'dropout_rate': 0.3, 'learning_rate': 0.0001}
```

In [135…

```
#Getting Prediction Values
gs_nn_train_pred,_,gs_nn_test_pred,_=fit_pred(gs_nn.best_estimator_,scaled_df_t
```

```
Epoch 1/45
  1/113 [..............................] - ETA: 45s - loss: 1.1708 - acc: 0.41
00 - recall: 0.5077 - precision: 0.5500
2023-04-06 04:16:40.981112: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
113/113 [==============================] - 1s 9ms/step - loss: 0.8927 - acc:
0.5479 - recall: 0.6196 - precision: 0.7146
Epoch 2/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8950 - acc:
0.5462 - recall: 0.6214 - precision: 0.7118
Epoch 3/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8905 - acc:
0.5471 - recall: 0.6160 - precision: 0.7155
Epoch 4/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8778 - acc:
0.5466 - recall: 0.6128 - precision: 0.7165
Epoch 5/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8820 - acc:
0.5451 - recall: 0.6129 - precision: 0.7147
Epoch 6/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8889 - acc:
0.5385 - recall: 0.6087 - precision: 0.7092
Epoch 7/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8799 - acc:
0.5440 - recall: 0.6086 - precision: 0.7156
Epoch 8/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8748 - acc:
0.5419 - recall: 0.6115 - precision: 0.7117
Epoch 9/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8834 - acc:
0.5427 - recall: 0.6078 - precision: 0.7144
Epoch 10/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8774 - acc:
0.5383 - recall: 0.6062 - precision: 0.7102
Epoch 11/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8777 - acc:
0.5350 - recall: 0.5994 - precision: 0.7097
Epoch 12/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8718 - acc:
0.5438 - recall: 0.6081 - precision: 0.7156
Epoch 13/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8612 - acc:
0.5453 - recall: 0.6092 - precision: 0.7168
Epoch 14/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8637 - acc:
0.5384 - recall: 0.6002 - precision: 0.7133
Epoch 15/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8730 - acc:
0.5355 - recall: 0.5958 - precision: 0.7120
Epoch 16/45
113/113 [==============================] - 1s 9ms/step - loss: 0.8695 - acc:
0.5390 - recall: 0.6025 - precision: 0.7128
Epoch 17/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8642 - acc:
0.5428 - recall: 0.6042 - precision: 0.7164
Epoch 18/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8511 - acc:
0.5404 - recall: 0.5971 - precision: 0.7172
Epoch 19/45
113/113 [==============================] - 1s 10ms/step - loss: 0.8641 - acc:
0.5332 - recall: 0.5934 - precision: 0.7105
Epoch 20/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8569 - acc:
0.5322 - recall: 0.5939 - precision: 0.7091
Epoch 21/45
```

```
113/113 [==============================] - 1s 8ms/step - loss: 0.8609 - acc:
0.5342 - recall: 0.5920 - precision: 0.7125
Epoch 22/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8535 - acc:
0.5364 - recall: 0.5950 - precision: 0.7135
Epoch 23/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8569 - acc:
0.5342 - recall: 0.5894 - precision: 0.7138
Epoch 24/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8511 - acc:
0.5383 - recall: 0.5958 - precision: 0.7154
Epoch 25/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8486 - acc:
0.5377 - recall: 0.5882 - precision: 0.7187
Epoch 26/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8496 - acc:
0.5343 - recall: 0.5871 - precision: 0.7152
Epoch 27/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8509 - acc:
0.5381 - recall: 0.5971 - precision: 0.7145
Epoch 28/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8422 - acc:
0.5316 - recall: 0.5808 - precision: 0.7151
Epoch 29/45
113/113 [==============================] - 1s 9ms/step - loss: 0.8460 - acc:
0.5368 - recall: 0.5913 - precision: 0.7160
Epoch 30/45
113/113 [==============================] - 1s 11ms/step - loss: 0.8444 - acc:
0.5299 - recall: 0.5829 - precision: 0.7120
Epoch 31/45
113/113 [==============================] - 1s 9ms/step - loss: 0.8342 - acc:
0.5326 - recall: 0.5810 - precision: 0.7163
Epoch 32/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8370 - acc:
0.5315 - recall: 0.5813 - precision: 0.7148
Epoch 33/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8401 - acc:
0.5298 - recall: 0.5810 - precision: 0.7128
Epoch 34/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8388 - acc:
0.5341 - recall: 0.5818 - precision: 0.7177
Epoch 35/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8281 - acc:
0.5402 - recall: 0.5905 - precision: 0.7205
Epoch 36/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8370 - acc:
0.5305 - recall: 0.5812 - precision: 0.7136
Epoch 37/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8420 - acc:
0.5290 - recall: 0.5794 - precision: 0.7127
Epoch 38/45
113/113 [==============================] - 1s 7ms/step - loss: 0.8295 - acc:
0.5280 - recall: 0.5732 - precision: 0.7148
Epoch 39/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8340 - acc:
0.5213 - recall: 0.5671 - precision: 0.7098
Epoch 40/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8311 - acc:
0.5208 - recall: 0.5686 - precision: 0.7084
Epoch 41/45
```

```
113/113 [==============================] - 1s 11ms/step - loss: 0.8235 - acc:
0.5306 - recall: 0.5793 - precision: 0.7147
Epoch 42/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8194 - acc:
0.5245 - recall: 0.5726 - precision: 0.7108
Epoch 43/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8279 - acc:
0.5285 - recall: 0.5736 - precision: 0.7152
Epoch 44/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8279 - acc:
0.5318 - recall: 0.5746 - precision: 0.7187
Epoch 45/45
113/113 [==============================] - 1s 8ms/step - loss: 0.8253 - acc:
0.5269 - recall: 0.5704 - precision: 0.7149
127/352 [=========>....................] - ETA: 0s
2023-04-06 04:17:22.935105: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
352/352 [==============================] - 0s 1ms/step
352/352 [==============================] - 0s 1ms/step
118/118 [==============================] - 0s 1ms/step
118/118 [==============================] - 0s 1ms/step
```

In [136…

```
start = time.time()
gs_nn_results = gs_nn.best_estimator_.model.fit(scaled_df_train, y_train, epoch
end = time.time()
print("Neural Net Fit Time:", end - start)
print(gs_rf.best_params_)
```

```
Epoch 1/45
 1/90 [..............................] - ETA: 27s - loss: 0.7712 - acc: 0.4700
- recall: 0.4722 - precision: 0.6939
2023-04-06 04:17:24.395105: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
90/90 [==============================] - ETA: 0s - loss: 0.7713 - acc: 0.5288
- recall: 0.5722 - precision: 0.7152
2023-04-06 04:17:25.590768: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
90/90 [==============================] - 2s 15ms/step - loss: 0.7713 - acc: 0.
5288 - recall: 0.5722 - precision: 0.7152 - val_loss: 0.7466 - val_acc: 0.5176
- val_recall: 0.5527 - val_precision: 0.7176
Epoch 2/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7678 - acc: 0.5
301 - recall: 0.5732 - precision: 0.7162 - val_loss: 0.7454 - val_acc: 0.5185
- val_recall: 0.5558 - val_precision: 0.7170
Epoch 3/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7704 - acc: 0.5
302 - recall: 0.5774 - precision: 0.7141 - val_loss: 0.7443 - val_acc: 0.5193
- val_recall: 0.5570 - val_precision: 0.7174
Epoch 4/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7657 - acc: 0.5
277 - recall: 0.5732 - precision: 0.7133 - val_loss: 0.7431 - val_acc: 0.5189
- val_recall: 0.5594 - val_precision: 0.7155
Epoch 5/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7642 - acc: 0.5
324 - recall: 0.5809 - precision: 0.7150 - val_loss: 0.7420 - val_acc: 0.5202
- val_recall: 0.5619 - val_precision: 0.7158
Epoch 6/45
90/90 [==============================] - 1s 12ms/step - loss: 0.7617 - acc: 0.
5330 - recall: 0.5842 - precision: 0.7139 - val_loss: 0.7409 - val_acc: 0.5220
- val_recall: 0.5643 - val_precision: 0.7167
Epoch 7/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7538 - acc: 0.5
319 - recall: 0.5803 - precision: 0.7146 - val_loss: 0.7398 - val_acc: 0.5238
- val_recall: 0.5674 - val_precision: 0.7173
Epoch 8/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7604 - acc: 0.5
367 - recall: 0.5897 - precision: 0.7156 - val_loss: 0.7387 - val_acc: 0.5256
- val_recall: 0.5699 - val_precision: 0.7181
Epoch 9/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7558 - acc: 0.5
331 - recall: 0.5866 - precision: 0.7128 - val_loss: 0.7376 - val_acc: 0.5269
- val_recall: 0.5717 - val_precision: 0.7188
Epoch 10/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7567 - acc: 0.5
445 - recall: 0.5975 - precision: 0.7209 - val_loss: 0.7365 - val_acc: 0.5278
- val_recall: 0.5729 - val_precision: 0.7192
Epoch 11/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7590 - acc: 0.5
331 - recall: 0.5871 - precision: 0.7125 - val_loss: 0.7355 - val_acc: 0.5282
- val_recall: 0.5741 - val_precision: 0.7191
Epoch 12/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7591 - acc: 0.5
365 - recall: 0.5924 - precision: 0.7140 - val_loss: 0.7344 - val_acc: 0.5291
- val_recall: 0.5766 - val_precision: 0.7189
Epoch 13/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7623 - acc: 0.5
367 - recall: 0.5942 - precision: 0.7133 - val_loss: 0.7333 - val_acc: 0.5305
- val_recall: 0.5790 - val_precision: 0.7192
Epoch 14/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7497 - acc: 0.5
463 - recall: 0.6041 - precision: 0.7196 - val_loss: 0.7323 - val_acc: 0.5291
- val_recall: 0.5803 - val_precision: 0.7169
Epoch 15/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7518 - acc: 0.5
472 - recall: 0.6067 - precision: 0.7192 - val_loss: 0.7313 - val_acc: 0.5313
- val_recall: 0.5839 - val_precision: 0.7176
Epoch 16/45
```

```
90/90 [==============================] - 1s 8ms/step - loss: 0.7575 - acc: 0.5
333 - recall: 0.5876 - precision: 0.7126 - val_loss: 0.7302 - val_acc: 0.5313
- val_recall: 0.5846 - val_precision: 0.7173
Epoch 17/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7527 - acc: 0.5
383 - recall: 0.6023 - precision: 0.7111 - val_loss: 0.7292 - val_acc: 0.5322
- val_recall: 0.5864 - val_precision: 0.7174
Epoch 18/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7461 - acc: 0.5
477 - recall: 0.6088 - precision: 0.7189 - val_loss: 0.7283 - val_acc: 0.5336
- val_recall: 0.5888 - val_precision: 0.7177
Epoch 19/45
90/90 [==============================] - 1s 13ms/step - loss: 0.7476 - acc: 0.
5422 - recall: 0.6027 - precision: 0.7154 - val_loss: 0.7273 - val_acc: 0.5349
- val_recall: 0.5919 - val_precision: 0.7177
Epoch 20/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7465 - acc: 0.5
523 - recall: 0.6142 - precision: 0.7214 - val_loss: 0.7263 - val_acc: 0.5367
- val_recall: 0.5944 - val_precision: 0.7185
Epoch 21/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7475 - acc: 0.5
484 - recall: 0.6101 - precision: 0.7189 - val_loss: 0.7254 - val_acc: 0.5376
- val_recall: 0.5956 - val_precision: 0.7189
Epoch 22/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7443 - acc: 0.5
536 - recall: 0.6303 - precision: 0.7149 - val_loss: 0.7244 - val_acc: 0.5371
- val_recall: 0.5974 - val_precision: 0.7174
Epoch 23/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7438 - acc: 0.5
556 - recall: 0.6335 - precision: 0.7155 - val_loss: 0.7235 - val_acc: 0.5380
- val_recall: 0.5993 - val_precision: 0.7175
Epoch 24/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7432 - acc: 0.5
565 - recall: 0.6334 - precision: 0.7166 - val_loss: 0.7226 - val_acc: 0.5389
- val_recall: 0.6005 - val_precision: 0.7179
Epoch 25/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7459 - acc: 0.5
535 - recall: 0.6337 - precision: 0.7131 - val_loss: 0.7216 - val_acc: 0.5407
- val_recall: 0.6029 - val_precision: 0.7188
Epoch 26/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7414 - acc: 0.5
520 - recall: 0.6270 - precision: 0.7146 - val_loss: 0.7207 - val_acc: 0.5411
- val_recall: 0.6048 - val_precision: 0.7183
Epoch 27/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7453 - acc: 0.5
558 - recall: 0.6386 - precision: 0.7132 - val_loss: 0.7198 - val_acc: 0.5411
- val_recall: 0.6060 - val_precision: 0.7177
Epoch 28/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7445 - acc: 0.5
533 - recall: 0.6340 - precision: 0.7127 - val_loss: 0.7189 - val_acc: 0.5416
- val_recall: 0.6085 - val_precision: 0.7170
Epoch 29/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7381 - acc: 0.5
684 - recall: 0.6474 - precision: 0.7230 - val_loss: 0.7180 - val_acc: 0.5416
- val_recall: 0.6097 - val_precision: 0.7163
Epoch 30/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7401 - acc: 0.5
546 - recall: 0.6378 - precision: 0.7123 - val_loss: 0.7171 - val_acc: 0.5420
- val_recall: 0.6103 - val_precision: 0.7165
Epoch 31/45
```

```
90/90 [==============================] - 1s 12ms/step - loss: 0.7406 - acc: 0.
5641 - recall: 0.6463 - precision: 0.7187 - val_loss: 0.7163 - val_acc: 0.5451
- val_recall: 0.6146 - val_precision: 0.7180
Epoch 32/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7402 - acc: 0.5
576 - recall: 0.6419 - precision: 0.7137 - val_loss: 0.7154 - val_acc: 0.5460
- val_recall: 0.6170 - val_precision: 0.7177
Epoch 33/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7358 - acc: 0.5
634 - recall: 0.6468 - precision: 0.7178 - val_loss: 0.7146 - val_acc: 0.5474
- val_recall: 0.6195 - val_precision: 0.7180
Epoch 34/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7370 - acc: 0.5
628 - recall: 0.6518 - precision: 0.7147 - val_loss: 0.7138 - val_acc: 0.5491
- val_recall: 0.6219 - val_precision: 0.7188
Epoch 35/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7340 - acc: 0.5
656 - recall: 0.6532 - precision: 0.7172 - val_loss: 0.7129 - val_acc: 0.5496
- val_recall: 0.6232 - val_precision: 0.7187
Epoch 36/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7317 - acc: 0.5
605 - recall: 0.6518 - precision: 0.7123 - val_loss: 0.7121 - val_acc: 0.5478
- val_recall: 0.6238 - val_precision: 0.7164
Epoch 37/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7379 - acc: 0.5
660 - recall: 0.6590 - precision: 0.7148 - val_loss: 0.7113 - val_acc: 0.5491
- val_recall: 0.6256 - val_precision: 0.7170
Epoch 38/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7294 - acc: 0.5
727 - recall: 0.6618 - precision: 0.7207 - val_loss: 0.7105 - val_acc: 0.5509
- val_recall: 0.6281 - val_precision: 0.7178
Epoch 39/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7291 - acc: 0.5
666 - recall: 0.6553 - precision: 0.7172 - val_loss: 0.7097 - val_acc: 0.5531
- val_recall: 0.6311 - val_precision: 0.7188
Epoch 40/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7285 - acc: 0.5
771 - recall: 0.6702 - precision: 0.7215 - val_loss: 0.7089 - val_acc: 0.5536
- val_recall: 0.6324 - val_precision: 0.7187
Epoch 41/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7268 - acc: 0.5
764 - recall: 0.6689 - precision: 0.7214 - val_loss: 0.7081 - val_acc: 0.5540
- val_recall: 0.6330 - val_precision: 0.7189
Epoch 42/45
90/90 [==============================] - 1s 9ms/step - loss: 0.7266 - acc: 0.5
741 - recall: 0.6646 - precision: 0.7209 - val_loss: 0.7073 - val_acc: 0.5545
- val_recall: 0.6354 - val_precision: 0.7181
Epoch 43/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7262 - acc: 0.5
712 - recall: 0.6632 - precision: 0.7185 - val_loss: 0.7066 - val_acc: 0.5549
- val_recall: 0.6366 - val_precision: 0.7180
Epoch 44/45
90/90 [==============================] - 1s 8ms/step - loss: 0.7269 - acc: 0.5
733 - recall: 0.6626 - precision: 0.7210 - val_loss: 0.7058 - val_acc: 0.5554
- val_recall: 0.6391 - val_precision: 0.7173
Epoch 45/45
90/90 [==============================] - 1s 11ms/step - loss: 0.7252 - acc: 0.
5822 - recall: 0.6785 - precision: 0.7230 - val_loss: 0.7051 - val_acc: 0.5549
- val_recall: 0.6397 - val_precision: 0.7165
Neural Net Fit Time: 37.01596713066101
```

```
{'rf__criterion': 'gini', 'rf__max_depth': 5, 'rf__min_samples_leaf': 5, 'rf__
n_estimators': 10, 'sm__sampling_strategy': 'minority'}
```

In [137…
```
nn_eval_metrics(gs_nn_results )
```

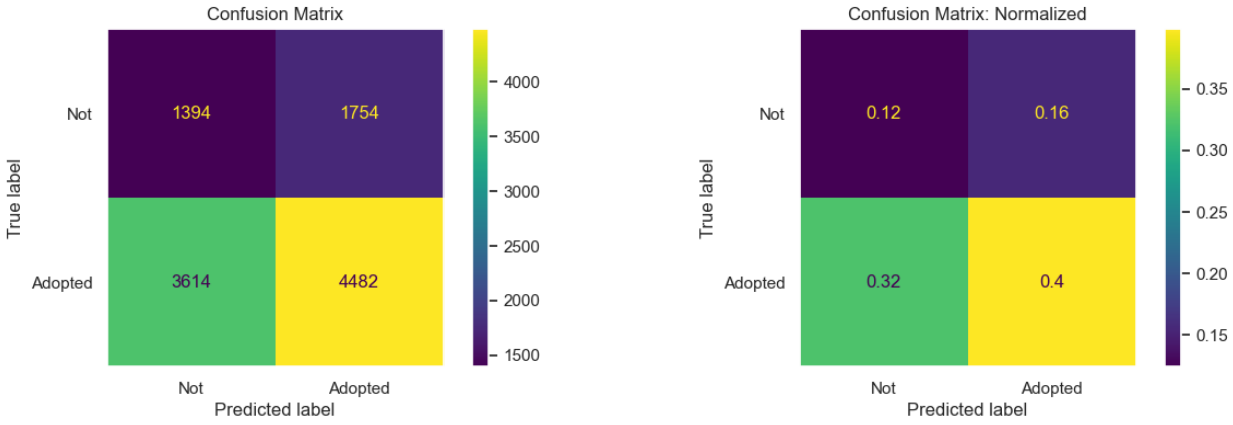
gs_nn.best_estimator_.fit

In [138…
```
#Printing out Test data classification report with scores
print("Train Classification Report:\n", classification_report(y_train,gs_nn_tra
print("Test Classification Report:\n", classification_report(y_test, gs_nn_test
```

```
Train Classification Report:
              precision    recall  f1-score   support

           0       0.28      0.44      0.34      3148
           1       0.72      0.55      0.63      8096

    accuracy                           0.52     11244
   macro avg       0.50      0.50      0.48     11244
weighted avg       0.60      0.52      0.55     11244

Test Classification Report:
              precision    recall  f1-score   support

           0       0.27      0.43      0.33      1049
           1       0.71      0.54      0.61      2700

    accuracy                           0.51      3749
   macro avg       0.49      0.48      0.47      3749
weighted avg       0.59      0.51      0.53      3749
```

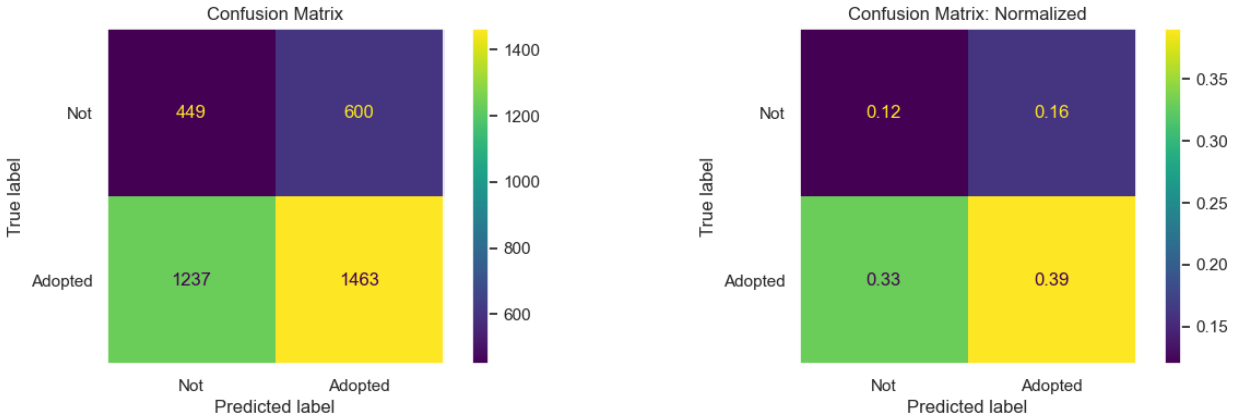
In [139…
```
#Confusion Matrix
print("Train Confusion Matrix:\n")
conf_matrix(y_train,gs_nn_train_pred )
```

```
Train Confusion Matrix:
```



In [140…
```
#Confusion Matrix
print("Test Confusion Matrix:\n")
conf_matrix(y_test,gs_nn_test_pred)
```

```
Test Confusion Matrix:
```



Model Evaluation

- They both have an average of ~16% FP rate from the Confusion Matrix. However the TP is low and the FN is high.
- The precision score were about 71%. This is one of the lowest out of all the models
- This model has a lot of variation and a bit overfit.
- The baseline Neural Net performed better. There should be more hyperparameter tuning to get a better model. The tuning made the model worse.

Best Estimator

The XGB Model with the hyperparamters tuned during gridsearch was the best model. This estimator beat the Random Forest model as the best due to the slightly better F1 Score, True Positive and False Negative rate.

In [141…
```
#Printing Metrics
calc_metrics(y_test,gs_xgb_test_pred)
```

```
The Precision mean score is: 0.81
The Recall mean score is: 0.78
The F1  score is: 0.8
The Accuracy mean score is: 0.71
```

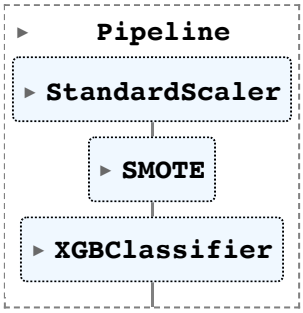
Out[141]:
```
(0.8122119815668203, 0.7833333333333333, 0.7975113122171946, 0.713523606295012)
```

In [142…
```
#Chosen paramters
print(gs_xgb.best_params_)
```

```
{'sm__sampling_strategy': 'minority', 'xgb__gamma': 3, 'xgb__learning_rate': 0.01, 'xgb__max_depth': 6, 'xgb__n_estimators': 120}
```

In [143…
```
#Display Best Estimator
gs_xgb.best_estimator_
```

Out[143]:

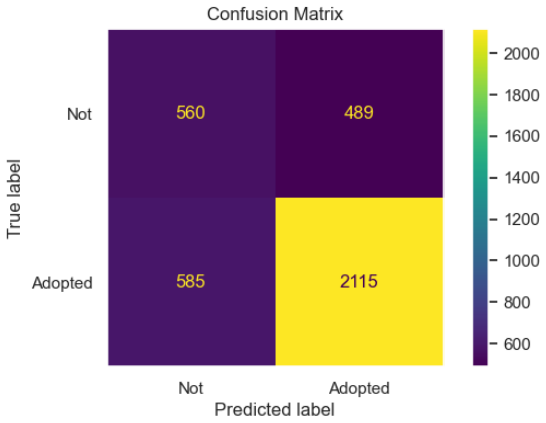


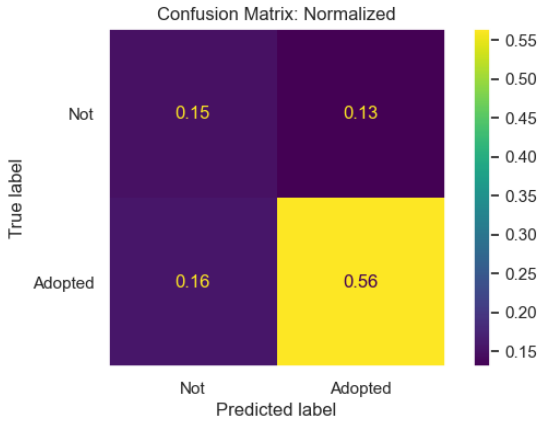
In [144…
```
#Printing out Test data classification report with scores
print("Test Classification Report:\n", classification_report(y_test, gs_xgb_tes
```

```
Test Classification Report:
               precision    recall  f1-score   support

           0       0.49      0.53      0.51      1049
           1       0.81      0.78      0.80      2700

    accuracy                           0.71      3749
   macro avg       0.65      0.66      0.65      3749
weighted avg       0.72      0.71      0.72      3749
```

In [145…
```
#Confusion Matrix
print("Test Confusion Matrix:\n")
conf_matrix(y_test,gs_xgb_test_pred)
```

```
Test Confusion Matrix:
```





In [146…
```
#Print Precision/Recall and AUC Curve
plot_curves(gs_xgb.best_estimator_,X_test,y_test)
```

Feature Importance

Feature Importance shows us what were the most impactful features in the data for the specific classifer. Before the start of modeling the data was correlated (including the target value) and evaluated to see the most correlated features. The is notebook will just get to understand the most important features without further modeling.

In [147…
```
#Get the best features from the best  model
best_model = gs_xgb.best_estimator_
feat_importance = best_model.steps[2][1].feature_importances_
```

In [148…
```
#Getting the current feature names
columns = X_train.columns
```

Creating a sorted dataframe of the most important features by name and importance level. Sorting the data allows for easier plotting.

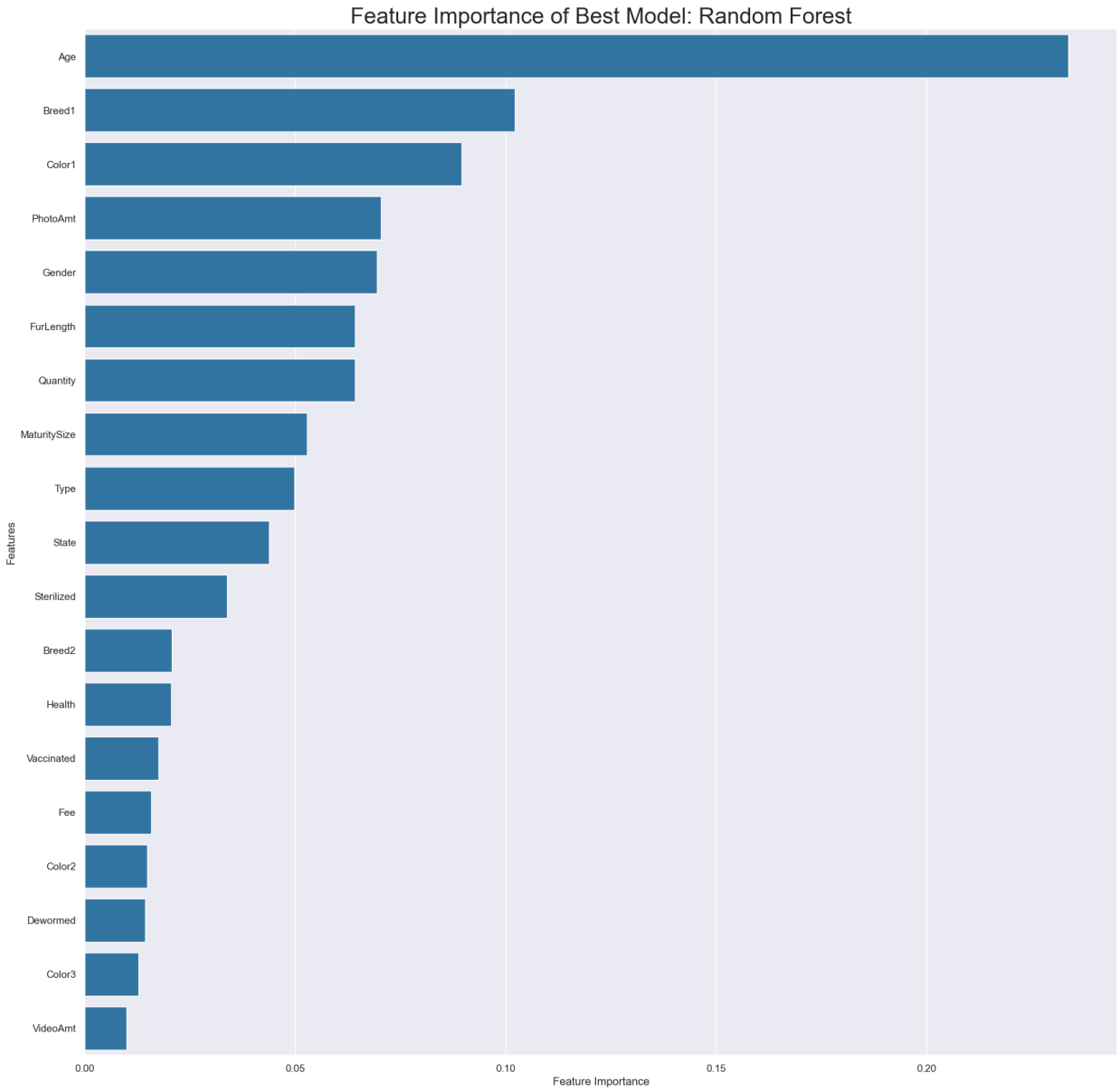
In [149…
```
#Creating a dataframe for feature importance
xgb_imp_features  = pd.DataFrame({"Features": columns,"Importance_Level": feat_
xgb_imp_features = xgb_imp_features.sort_values(by = "Importance_Level",axis =
xgb_imp_features
```

Out[149]:

	Features	Importance_Level
0	Age	0.233659
1	Breed1	0.102191
2	Color1	0.089552
3	PhotoAmt	0.070355
4	Gender	0.069488
5	FurLength	0.064154
6	Quantity	0.064148
7	MaturitySize	0.052747
8	Type	0.049836
9	State	0.043807
10	Sterilized	0.033758
11	Breed2	0.020655
12	Health	0.020540
13	Vaccinated	0.017548
14	Fee	0.015769
15	Color2	0.014807
16	Dewormed	0.014274
17	Color3	0.012772
18	VideoAmt	0.009939

Plotting the feature importance

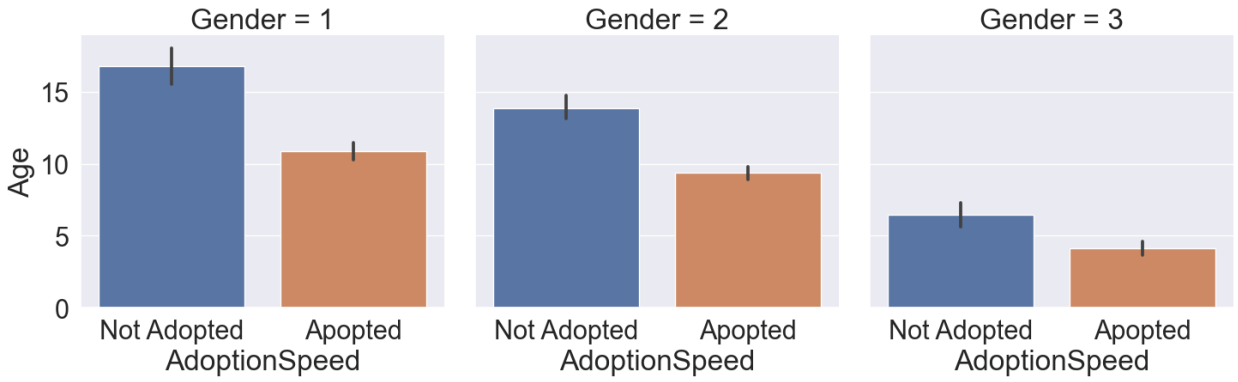
In [150…
```
#Plotting Importance from Best Model
sns.barplot(x = feat_importance,
            y = columns,
            data = xgb_imp_features,
            color = 'tab:blue',
            order=xgb_imp_features["Features"],
            orient = 'h')
sns.set(rc={'figure.figsize':(30,20)},font_scale= 2)
plt.title("Feature Importance of Best Model: Random Forest",)
plt.xlabel('Feature Importance')
plt.ylabel('Features')
plt.show()
plt.savefig("images/feat_imp.png")
```




```
<Figure size 3000x2000 with 0 Axes>
```

In [151…
```
#Age, Type, Gender
ag = sns.catplot(data = main_df, y = "Age", x = "AdoptionSpeed", col = "Gender'
ag.set_xticklabels(["Not Adopted","Apopted"])
```

Out[151]:
```
<seaborn.axisgrid.FacetGrid at 0x2dbae99f0>
```



Choosing the top 5 features from the sorted feature importance list

In [152…
```
#Top 5 Features
xgb_imp_features[0:5]
```

Out[152]:

	Features	Importance_Level
0	Age	0.233659
1	Breed1	0.102191
2	Color1	0.089552
3	PhotoAmt	0.070355
4	Gender	0.069488

- The top two features are the same as the results from the initial correlation
- PhotoAmt and Color were initial weakly correlated to the Adoption Speed
- The Breed would help understand the animal without the Type explicitly known
- Knowing the photoAmt may help us to know that animals with photos and possibly multiple may have an easier time being adopted

Conclusion

Reccomendations

- Use model with an experienced rescuer
- Prioritize adoption form attributes
  - The feature importance shows with are the driving factors to understand if a animal will be adopted
- Plan cost with ~16% margin
- Acquire photos of all rescues

Limitations

- Deeper explantion of attributes
- Target Class imbalance
- Synthetic Data used
- HW Resources: Hyperparamter tuning resource intensive
- Time for more hypertuning
- Analysis on numerical tabular attributes only

Future Next Steps

- Photo Analysis (Image Classification)
- Textual Analysis (Natural Language Processing)
- Recommend specific attributes to rescue first