Q1-advertising

April 17, 2021

0.0.1 PROBLEM STATEMENT for ANN:

In this assignment you will be working with a dummy advertising data set, indicating whether or not a particular internet user clicked on an Advertisement on a company website. you will try to create a model that will predict whether or not they will click on an ad based on the features of that user.

This data set contains the following features:

- 'Daily Time Spent on Site': consumer time on site in minutes
- 'Age': customer age in years
- 'Area Income': Avg. Income of geographical area of consumer
- 'Daily Internet Usage': Avg. minutes a day consumer is on the internet
- 'Ad Topic Line': Headline of the advertisement
- 'City': City of consumer
- 'Male': Whether or not consumer was male
- 'Country': Country of consumer
- 'Timestamp': Time at which consumer clicked on Ad or closed window
- 'Clicked on Ad': 0 or 1 indicated clicking on Ad

For the dataset (Advertising dataset), implement the ANN classifier using Keras in Python. [5M]

Dataset: Advertising Dataset.csv

0.1 1. Import the libraries and Load the dataset and Remove/replace missing values

[35]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from tensorflow.keras.layers import Dropout
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report,confusion_matrix
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.models import Sequential
```

```python
from tensorflow.keras.layers import Dense, Dropout, Activation
from sklearn.preprocessing import MinMaxScaler
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
```

[2]:
```python
adf=pd.read_csv('advertising-1.csv',na_values='?')
```

[3]:
```python
adf.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 10 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Daily Time Spent on Site  1000 non-null   float64
 1   Age                       1000 non-null   int64
 2   Area Income               1000 non-null   float64
 3   Daily Internet Usage      1000 non-null   float64
 4   Ad Topic Line             1000 non-null   object
 5   City                      1000 non-null   object
 6   Male                      1000 non-null   int64
 7   Country                   1000 non-null   object
 8   Timestamp                 1000 non-null   object
 9   Clicked on Ad             1000 non-null   int64
dtypes: float64(3), int64(3), object(4)
memory usage: 78.2+ KB
```

[4]:
```python
print(adf.columns)
print ("Shape of Data :" , adf.shape)
print ("\nFeatures :" ,adf.columns.tolist())
print ("\nMissing values : ", adf.isnull().sum().values.sum())
print ("\nUnique values :  ", adf.nunique(),'\n')
adf.head()
```

```
Index(['Daily Time Spent on Site', 'Age', 'Area Income',
       'Daily Internet Usage', 'Ad Topic Line', 'City', 'Male', 'Country',
       'Timestamp', 'Clicked on Ad'],
      dtype='object')
Shape of Data : (1000, 10)

Features : ['Daily Time Spent on Site', 'Age', 'Area Income', 'Daily Internet
Usage', 'Ad Topic Line', 'City', 'Male', 'Country', 'Timestamp', 'Clicked on
Ad']

Missing values :  0
```

```
Unique values :   Daily Time Spent on Site     900
Age                          43
Area Income                1000
Daily Internet Usage        966
Ad Topic Line              1000
City                        969
Male                          2
Country                     237
Timestamp                  1000
Clicked on Ad                 2
dtype: int64
```

[4]:
```
   Daily Time Spent on Site  Age  Area Income  Daily Internet Usage  \
0                     68.95   35     61833.90                256.09
1                     80.23   31     68441.85                193.77
2                     69.47   26     59785.94                236.50
3                     74.15   29     54806.18                245.89
4                     68.37   35     73889.99                225.58

                         Ad Topic Line            City  Male     Country  \
0     Cloned 5thgeneration orchestration     Wrightburgh     0     Tunisia
1     Monitored national standardization       West Jodi     1       Nauru
2       Organic bottom-line service-desk        Davidton     0  San Marino
3  Triple-buffered reciprocal time-frame  West Terrifurt     1       Italy
4          Robust logistical utilization    South Manuel     0     Iceland

             Timestamp  Clicked on Ad
0  2016-03-27 00:53:11              0
1  2016-04-04 01:39:02              0
2  2016-03-13 20:35:42              0
3  2016-01-10 02:31:19              0
4  2016-06-03 03:36:18              0
```

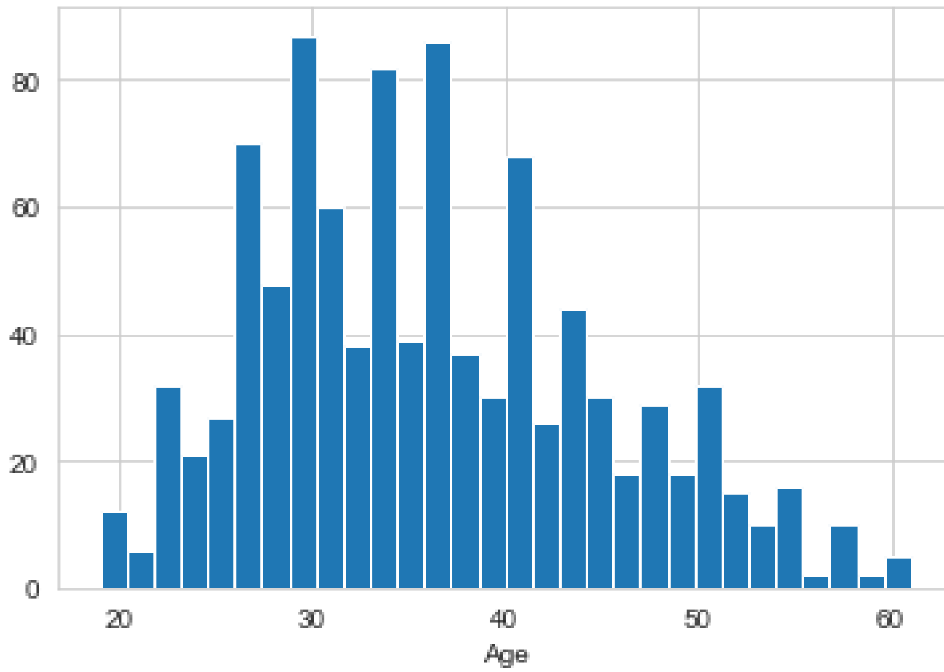
- No Missing Values Observed

0.1.1 1.1 Exploratory Data Analysis

1.1.1 Create Histogram of the AGE

[5]:
```
sns.set_style('whitegrid')
adf['Age'].hist(bins=30)
plt.xlabel('Age')
```

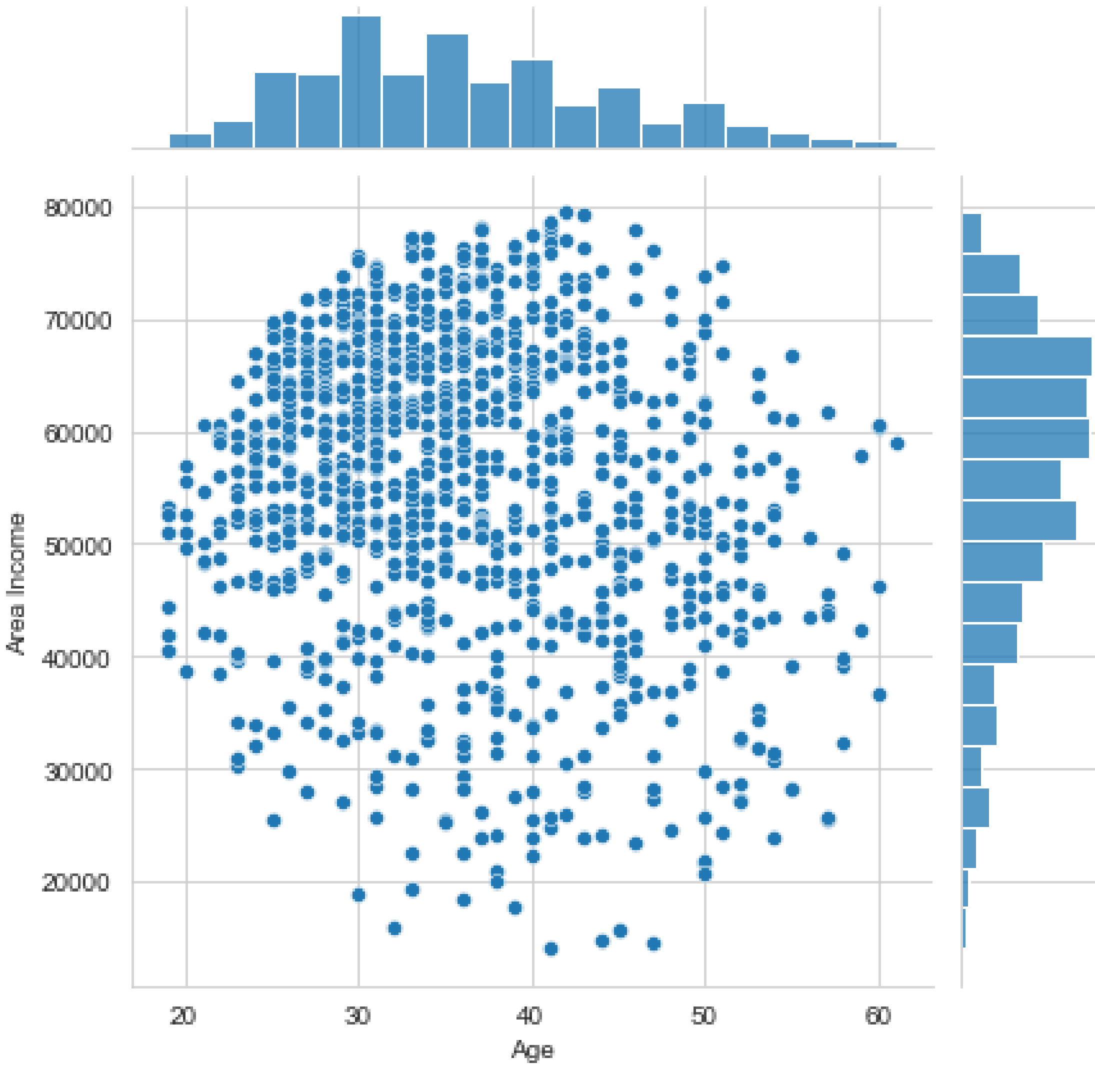
[5]:
```
Text(0.5, 0, 'Age')
```



Most of the internet users Age in between 28 - 40 ###### 1.1.2 Joint plot - Area Income Vs. Age

[6]:
```
sns.jointplot(x='Age',y='Area Income',data=adf)
```

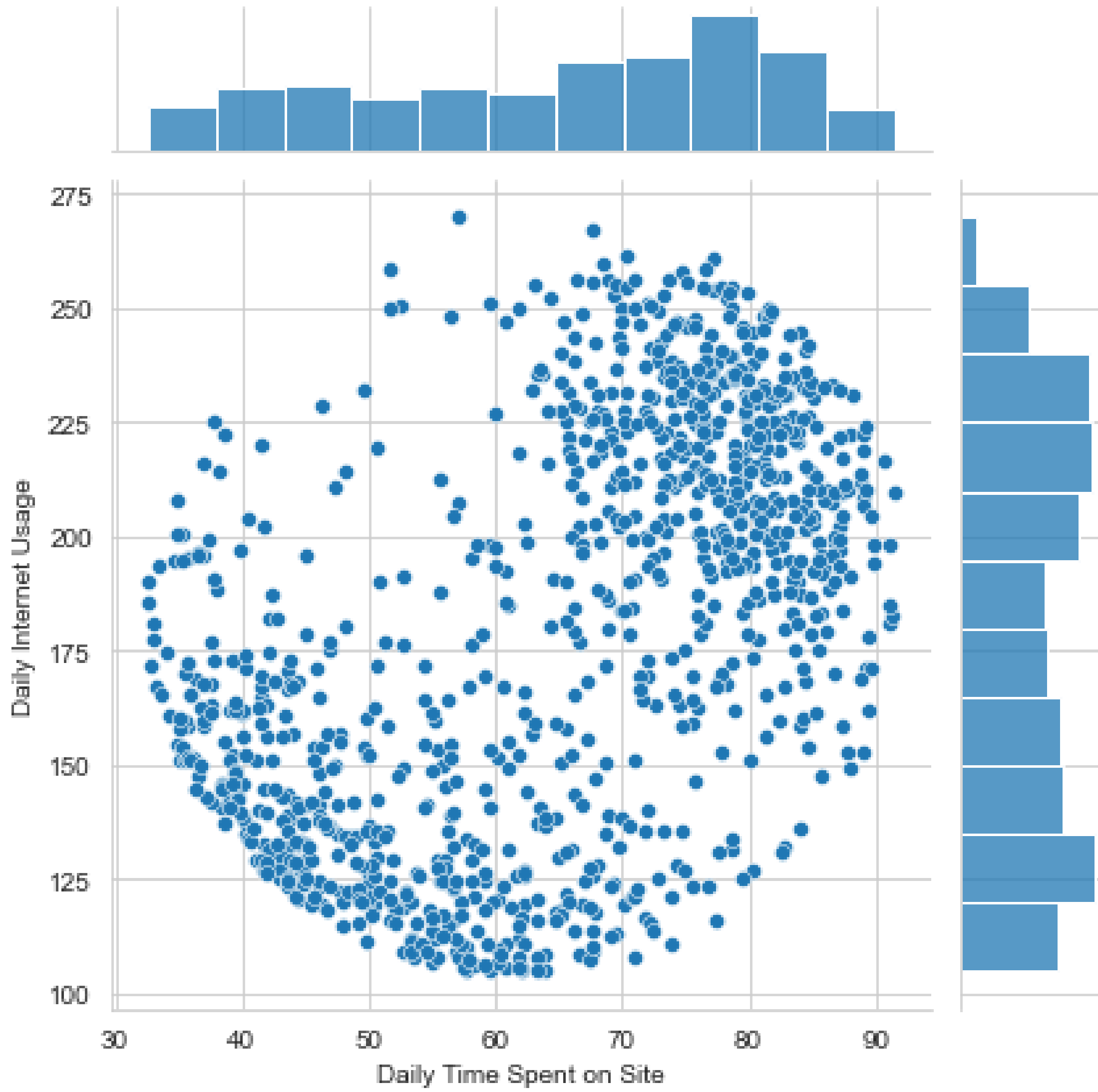
[6]: <seaborn.axisgrid.JointGrid at 0x15fab533a58>



1.1.3 jointplot showing the Daily Time spent on site vs. Daily Internet Usage

[7]:
```
sns.jointplot(x='Daily Time Spent on Site', y='Daily Internet Usage', data= adf)
```

[7]: <seaborn.axisgrid.JointGrid at 0x15fab6ae978>

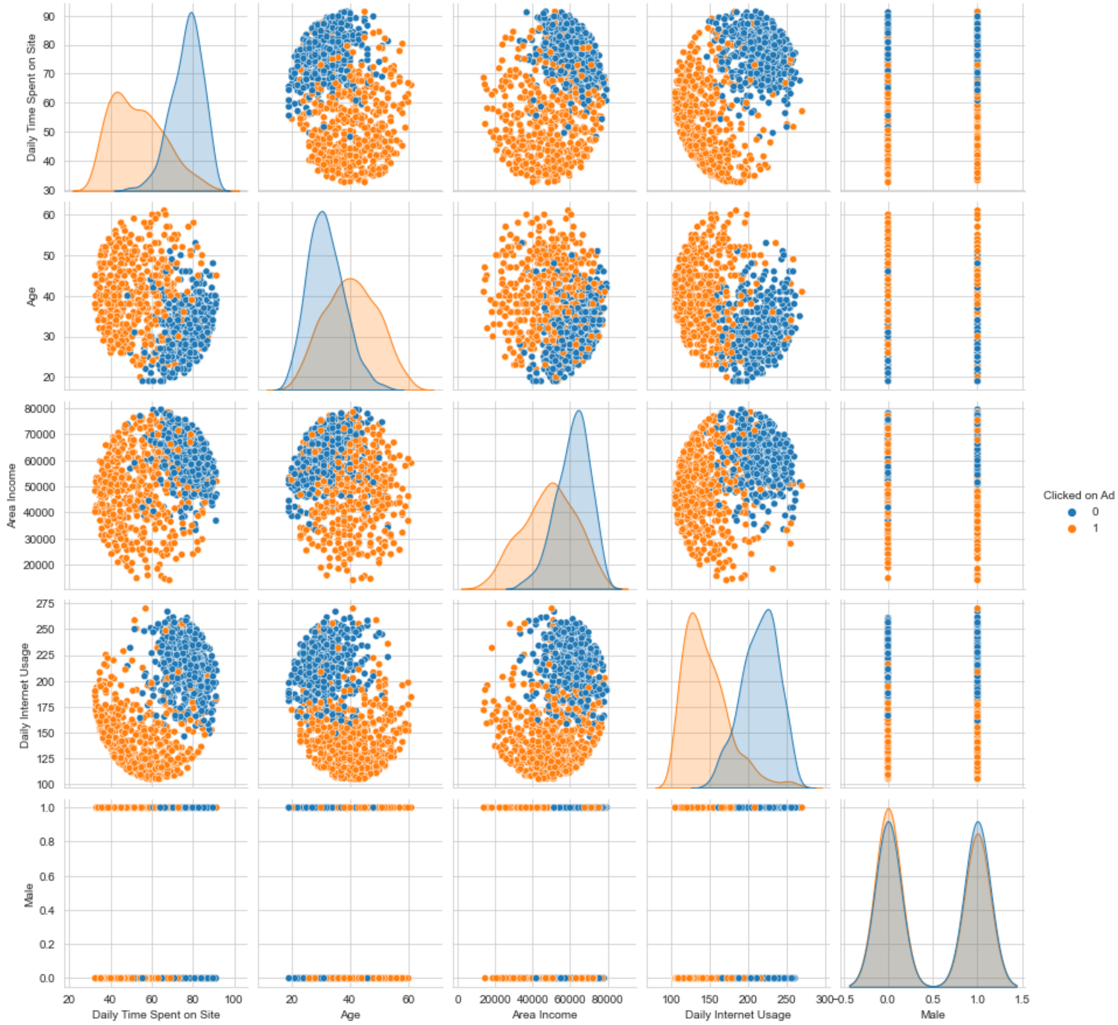


We can see from the plot the users who spend more time on internet tend to spend more time on the website

1.1.4 Pair Plot to see the relationship of all features considering if they have Clicked on Ad on Not

[8]:
```
sns.pairplot(adf, hue='Clicked on Ad')
```

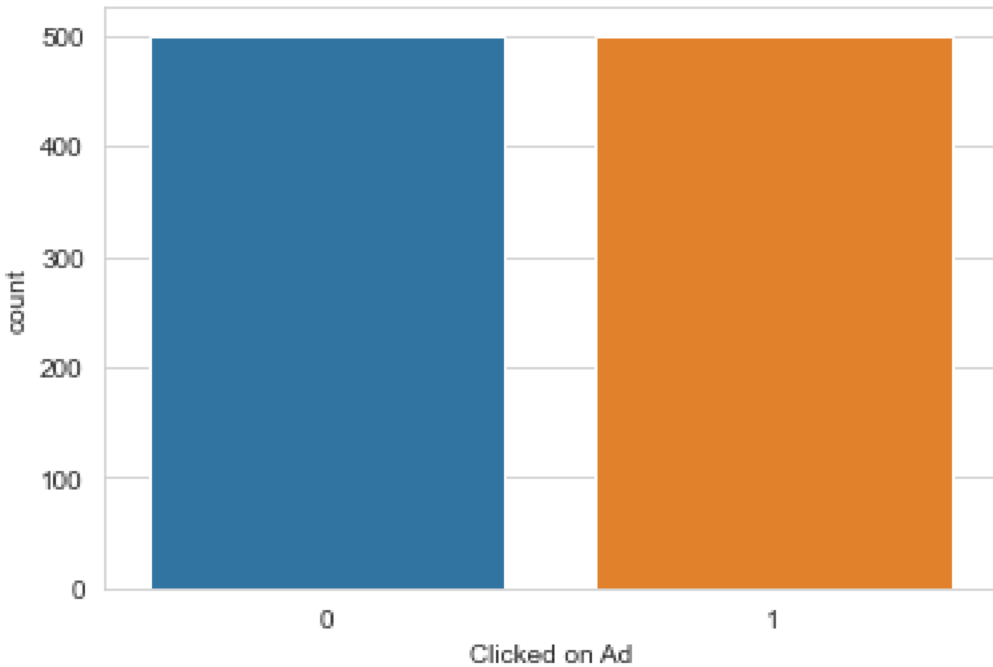
[8]: <seaborn.axisgrid.PairGrid at 0x15fab7f1e80>



1.1.5 Target Class Distribution

[9]:
```
sns.set_style('whitegrid')
sns.countplot(x='Clicked on Ad', data=adf)
```

[9]: <AxesSubplot:xlabel='Clicked on Ad', ylabel='count'>



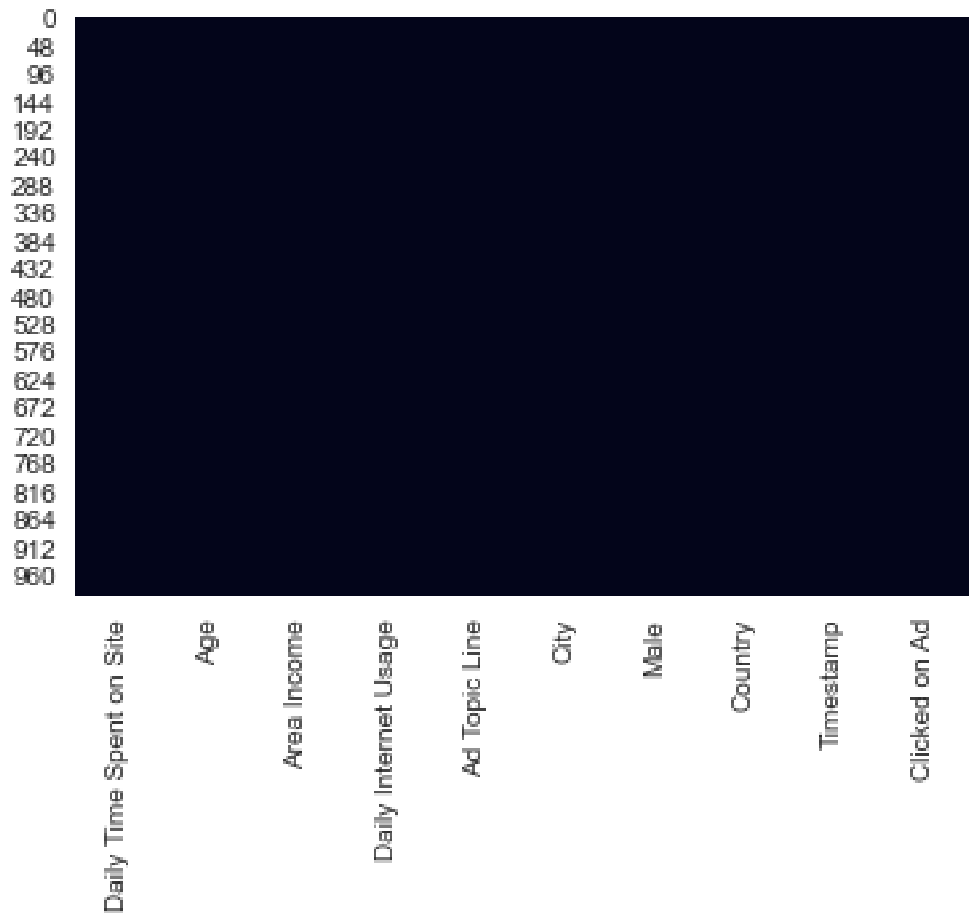
Above graph shows that the Target class for "Clicked & Not Clicked on Ad" are equally distributed

0.1.2 1.2 Cleaning the Data

1.2.1 Check if there are any missing values

[10]:
```
sns.heatmap(adf.isnull(), cbar=False)
```

[10]:
```
<AxesSubplot:>
```



There are no missing values in the given data

1.2.2 Identify and Convert Categorical Values to Numberical Values

[11]:
```
adf.dtypes
```

[11]:
```
Daily Time Spent on Site    float64
Age                           int64
Area Income                 float64
Daily Internet Usage        float64
Ad Topic Line                object
City                         object
Male                          int64
Country                      object
Timestamp                    object
Clicked on Ad                 int64
dtype: object
```

Here, we have some non numerical values such as “City”, “Ad Topic Line”, “Country”, “Timestamp". Since we cannot use them as an input to the machine learning model, we replace them with numerical codes.

[12]:
```
adf['City Codes']= adf['City'].astype('category').cat.codes
adf['Country Codes'] = adf['Country'].astype('category').cat.codes
adf[['City Codes','Country Codes']].head()
```

[12]:
```
   City Codes  Country Codes
0         961            215
1         903            147
2         111            184
3         939            103
4         805             96
```

[13]:
```
adf['Month'] = adf['Timestamp'].apply(lambda x: x.split('-')[1])
adf['Hour'] = adf['Timestamp'].apply(lambda x: x.split(':')[0].split(' ')[1])
adf[['Month','Hour']].head()
```

[13]:
```
  Month Hour
0    03   00
1    04   01
2    03   20
3    01   02
4    06   03
```

1.2.3 Droping Extra Features

- We have already converted the non numerical data to numerical values.
- Dropping the remaining non-numerical columns.

[14]:
```
adf_updata = adf.drop(labels=['Ad Topic Line','City','Country','Timestamp'],␣
 ↪axis=1)
adf_updata.head()
```

[14]:
```
   Daily Time Spent on Site  Age  Area Income  Daily Internet Usage  Male  \
0                     68.95   35     61833.90                256.09     0
1                     80.23   31     68441.85                193.77     1
2                     69.47   26     59785.94                236.50     0
3                     74.15   29     54806.18                245.89     1
4                     68.37   35     73889.99                225.58     0

   Clicked on Ad  City Codes  Country Codes Month Hour
0              0         961            215    03   00
1              0         903            147    04   01
2              0         111            184    03   20
3              0         939            103    01   02
4              0         805             96    06   03
```

```
[15]: adf_updata.columns
```

```
[15]: Index(['Daily Time Spent on Site', 'Age', 'Area Income',
             'Daily Internet Usage', 'Male', 'Clicked on Ad', 'City Codes',
             'Country Codes', 'Month', 'Hour'],
            dtype='object')
```

0.2 2. Split features and labels

```
[16]: X = adf_updata[['Daily Time Spent on Site', 'Age', 'Area Income',
             'Daily Internet Usage', 'Male',
             'Country Codes', 'City Codes', 'Month', 'Hour']]
      y = adf_updata['Clicked on Ad']
```

here, we have taken the class label 'Clicked on Ad' as 'y'(Lower case - y, because it is one dimentional data) and all remaining features as 'X'

0.3 3. Split train and test data

```
[17]: from sklearn.model_selection import train_test_split
```

```
[18]: X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.30,␣
       ↪random_state=42)
```

0.4 4. Implement ANN Classifier using Keras

0.4.1 4.1 Normalizing the Data

Used MinMaxScaler to normalize the feature data X_train and X_test. We don't want data leakage from the test set, so we only fit on the X_train data

```
[19]: scaler = MinMaxScaler()
      X_train = scaler.fit_transform(X_train)
      X_test = scaler.transform(X_test)
```

```
[20]: X_train.shape
```

```
[20]: (700, 9)
```

```
[21]: X_train
```

```
[21]: array([[0.73176951, 0.47619048, 0.76387767, …, 0.05165289, 0.66666667,
              0.08695652],
             [0.22845487, 0.30952381, 0.78645239, …, 0.0196281 , 0.66666667,
              0.86956522],
             [0.62587115, 0.14285714, 0.7908996 , …, 0.07128099, 0.16666667,
              0.17391304],
```

```
…,
[0.99898011, 0.61904762, 0.57909566, …, 0.42975207, 0.5       ,
 0.30434783],
[0.40897501, 0.54761905, 0.89615916, …, 0.39772727, 0.16666667,
 0.43478261],
[0.97416284, 0.5       , 0.69626269, …, 0.88739669, 1.        ,
 0.60869565]])
```

0.4.2 4.2 Creating the Model

4.2.1 TRAIL - 01

- Considering 8 & 4 multiplying with number of class labels(0,1), and final output as 1 neuron.
- it is a binary classification problem we have given the activation function as 'sigmoid' for the output.
- ran it for 600 epochs

[22]:
```
model = Sequential()
model.add(Dense(units=16,activation='relu'))
model.add(Dense(units=8,activation='relu'))
model.add(Dense(units=1,activation='sigmoid'))
# For a binary classification problem
model.compile(loss='binary_crossentropy', optimizer='adam')
```

[23]:
```
# Train the Model
model.fit(x=X_train,
          y=y_train,
          epochs=600,
          validation_data=(X_test, y_test), verbose=1
          )
```

```
Epoch 1/600
22/22 [==============================] - 3s 113ms/step - loss: 0.7109 -
val_loss: 0.6807
Epoch 2/600
22/22 [==============================] - 0s 13ms/step - loss: 0.6755 - val_loss:
0.6463
Epoch 3/600
22/22 [==============================] - 0s 12ms/step - loss: 0.6397 - val_loss:
0.6141
Epoch 4/600
22/22 [==============================] - 0s 8ms/step - loss: 0.6045 - val_loss:
0.5804
Epoch 5/600
22/22 [==============================] - 0s 13ms/step - loss: 0.5642 - val_loss:
0.5423
Epoch 6/600
22/22 [==============================] - 0s 8ms/step - loss: 0.5209 - val_loss:
```

```
0.5007
Epoch 7/600
22/22 [==============================] - 0s 9ms/step - loss: 0.4775 - val_loss:
0.4528
Epoch 8/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4312 - val_loss:
0.4050
Epoch 9/600
22/22 [==============================] - 0s 9ms/step - loss: 0.3861 - val_loss:
0.3588
Epoch 10/600
22/22 [==============================] - 0s 7ms/step - loss: 0.3232 - val_loss:
0.3172
Epoch 11/600
22/22 [==============================] - 0s 8ms/step - loss: 0.2806 - val_loss:
0.2852
Epoch 12/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2541 - val_loss:
0.2570
Epoch 13/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2220 - val_loss:
0.2358
Epoch 14/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1942 - val_loss:
0.2190
Epoch 15/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1929 - val_loss:
0.2090
Epoch 16/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1628 - val_loss:
0.1984
Epoch 17/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1665 - val_loss:
0.1912
Epoch 18/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1586 - val_loss:
0.1838
Epoch 19/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1250 - val_loss:
0.1805
Epoch 20/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1340 - val_loss:
0.1760
Epoch 21/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1449 - val_loss:
0.1732
Epoch 22/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1164 - val_loss:
```

```
0.1719
Epoch 23/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1478 - val_loss:
0.1701
Epoch 24/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1133 - val_loss:
0.1663
Epoch 25/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1100 - val_loss:
0.1666
Epoch 26/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1133 - val_loss:
0.1635
Epoch 27/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1011 - val_loss:
0.1626
Epoch 28/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1061 - val_loss:
0.1620
Epoch 29/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1117 - val_loss:
0.1631
Epoch 30/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0968 - val_loss:
0.1595
Epoch 31/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1176 - val_loss:
0.1586
Epoch 32/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0884 - val_loss:
0.1586
Epoch 33/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1293 - val_loss:
0.1575
Epoch 34/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1073 - val_loss:
0.1563
Epoch 35/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0895 - val_loss:
0.1567
Epoch 36/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0735 - val_loss:
0.1560
Epoch 37/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0969 - val_loss:
0.1562
Epoch 38/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1259 - val_loss:
```

```
0.1544
Epoch 39/600
22/22 [==============================] - 0s 16ms/step - loss: 0.1047 - val_loss:
0.1535
Epoch 40/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0876 - val_loss:
0.1533
Epoch 41/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0828 - val_loss:
0.1534
Epoch 42/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0912 - val_loss:
0.1526
Epoch 43/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0832 - val_loss:
0.1527
Epoch 44/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0732 - val_loss:
0.1513
Epoch 45/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0976 - val_loss:
0.1514
Epoch 46/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0899 - val_loss:
0.1514
Epoch 47/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0907 - val_loss:
0.1526
Epoch 48/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0875 - val_loss:
0.1506
Epoch 49/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0921 - val_loss:
0.1515
Epoch 50/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0968 - val_loss:
0.1495
Epoch 51/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1097 - val_loss:
0.1505
Epoch 52/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0671 - val_loss:
0.1495
Epoch 53/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0607 - val_loss:
0.1496
Epoch 54/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0844 - val_loss:
```

```
0.1493
Epoch 55/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0741 - val_loss:
0.1483
Epoch 56/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0632 - val_loss:
0.1486
Epoch 57/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0830 - val_loss:
0.1484
Epoch 58/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0883 - val_loss:
0.1491
Epoch 59/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0629 - val_loss:
0.1477
Epoch 60/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0767 - val_loss:
0.1481
Epoch 61/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0734 - val_loss:
0.1479
Epoch 62/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0979 - val_loss:
0.1479
Epoch 63/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0925 - val_loss:
0.1473
Epoch 64/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0647 - val_loss:
0.1469
Epoch 65/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0943 - val_loss:
0.1475
Epoch 66/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0720 - val_loss:
0.1468
Epoch 67/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0774 - val_loss:
0.1470
Epoch 68/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0759 - val_loss:
0.1466
Epoch 69/600
22/22 [==============================] - 0s 16ms/step - loss: 0.0697 - val_loss:
0.1464
Epoch 70/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0815 - val_loss:
```

```
0.1476
Epoch 71/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0715 - val_loss:
0.1467
Epoch 72/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0838 - val_loss:
0.1463
Epoch 73/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0653 - val_loss:
0.1465
Epoch 74/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0787 - val_loss:
0.1465
Epoch 75/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0718 - val_loss:
0.1470
Epoch 76/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0631 - val_loss:
0.1473
Epoch 77/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0602 - val_loss:
0.1466
Epoch 78/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0860 - val_loss:
0.1459
Epoch 79/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0551 - val_loss:
0.1460
Epoch 80/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0687 - val_loss:
0.1471
Epoch 81/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0809 - val_loss:
0.1472
Epoch 82/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0629 - val_loss:
0.1473
Epoch 83/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0916 - val_loss:
0.1468
Epoch 84/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0664 - val_loss:
0.1467
Epoch 85/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0621 - val_loss:
0.1467
Epoch 86/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0706 - val_loss:
```

```
0.1467
Epoch 87/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0654 - val_loss:
0.1470
Epoch 88/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0595 - val_loss:
0.1467
Epoch 89/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0610 - val_loss:
0.1471
Epoch 90/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0782 - val_loss:
0.1468
Epoch 91/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0633 - val_loss:
0.1470
Epoch 92/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0550 - val_loss:
0.1471
Epoch 93/600
22/22 [==============================] - 0s 19ms/step - loss: 0.0641 - val_loss:
0.1476
Epoch 94/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0650 - val_loss:
0.1471
Epoch 95/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0760 - val_loss:
0.1483
Epoch 96/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0658 - val_loss:
0.1478
Epoch 97/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0510 - val_loss:
0.1481
Epoch 98/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0511 - val_loss:
0.1486
Epoch 99/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0598 - val_loss:
0.1484
Epoch 100/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0474 - val_loss:
0.1491
Epoch 101/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0788 - val_loss:
0.1490
Epoch 102/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0694 - val_loss:
```

```
0.1489
Epoch 103/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0492 - val_loss:
0.1492
Epoch 104/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0554 - val_loss:
0.1493
Epoch 105/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0624 - val_loss:
0.1499
Epoch 106/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0651 - val_loss:
0.1494
Epoch 107/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0528 - val_loss:
0.1505
Epoch 108/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0614 - val_loss:
0.1497
Epoch 109/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0607 - val_loss:
0.1497
Epoch 110/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0566 - val_loss:
0.1499
Epoch 111/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0622 - val_loss:
0.1526
Epoch 112/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0620 - val_loss:
0.1502
Epoch 113/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0673 - val_loss:
0.1511
Epoch 114/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0463 - val_loss:
0.1499
Epoch 115/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0499 - val_loss:
0.1509
Epoch 116/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0484 - val_loss:
0.1517
Epoch 117/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0694 - val_loss:
0.1520
Epoch 118/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0651 - val_loss:
```

```
0.1510
Epoch 119/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0612 - val_loss:
0.1513
Epoch 120/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0480 - val_loss:
0.1516
Epoch 121/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0659 - val_loss:
0.1510
Epoch 122/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0483 - val_loss:
0.1522
Epoch 123/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0508 - val_loss:
0.1527
Epoch 124/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0570 - val_loss:
0.1524
Epoch 125/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0587 - val_loss:
0.1534
Epoch 126/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0528 - val_loss:
0.1523
Epoch 127/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0648 - val_loss:
0.1531
Epoch 128/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0402 - val_loss:
0.1539
Epoch 129/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0531 - val_loss:
0.1540
Epoch 130/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0522 - val_loss:
0.1524
Epoch 131/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0549 - val_loss:
0.1537
Epoch 132/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0469 - val_loss:
0.1548
Epoch 133/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0710 - val_loss:
0.1527
Epoch 134/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0496 - val_loss:
```

```
0.1544
Epoch 135/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0566 - val_loss:
0.1542
Epoch 136/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0589 - val_loss:
0.1544
Epoch 137/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0437 - val_loss:
0.1536
Epoch 138/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0446 - val_loss:
0.1550
Epoch 139/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0582 - val_loss:
0.1556
Epoch 140/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0478 - val_loss:
0.1558
Epoch 141/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0626 - val_loss:
0.1553
Epoch 142/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0539 - val_loss:
0.1557
Epoch 143/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0540 - val_loss:
0.1573
Epoch 144/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0462 - val_loss:
0.1565
Epoch 145/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0760 - val_loss:
0.1565
Epoch 146/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0500 - val_loss:
0.1567
Epoch 147/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0574 - val_loss:
0.1564
Epoch 148/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0503 - val_loss:
0.1590
Epoch 149/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0457 - val_loss:
0.1564
Epoch 150/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0673 - val_loss:
```

```
0.1581
Epoch 151/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0457 - val_loss:
0.1574
Epoch 152/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0687 - val_loss:
0.1589
Epoch 153/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0403 - val_loss:
0.1585
Epoch 154/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0565 - val_loss:
0.1581
Epoch 155/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0575 - val_loss:
0.1580
Epoch 156/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0478 - val_loss:
0.1604
Epoch 157/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0838 - val_loss:
0.1589
Epoch 158/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0559 - val_loss:
0.1605
Epoch 159/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0429 - val_loss:
0.1591
Epoch 160/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0509 - val_loss:
0.1599
Epoch 161/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0407 - val_loss:
0.1618
Epoch 162/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0516 - val_loss:
0.1607
Epoch 163/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0393 - val_loss:
0.1603
Epoch 164/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0547 - val_loss:
0.1606
Epoch 165/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0456 - val_loss:
0.1611
Epoch 166/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0683 - val_loss:
```

```
0.1611
Epoch 167/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0514 - val_loss:
0.1611
Epoch 168/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0485 - val_loss:
0.1632
Epoch 169/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0432 - val_loss:
0.1620
Epoch 170/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0599 - val_loss:
0.1618
Epoch 171/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0541 - val_loss:
0.1631
Epoch 172/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0437 - val_loss:
0.1615
Epoch 173/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0500 - val_loss:
0.1615
Epoch 174/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0509 - val_loss:
0.1626
Epoch 175/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0388 - val_loss:
0.1631
Epoch 176/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0437 - val_loss:
0.1640
Epoch 177/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0417 - val_loss:
0.1641
Epoch 178/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0524 - val_loss:
0.1635
Epoch 179/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0566 - val_loss:
0.1635
Epoch 180/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0426 - val_loss:
0.1636
Epoch 181/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0533 - val_loss:
0.1643
Epoch 182/600
22/22 [==============================] - ETA: 0s - loss: 0.119 - 0s 8ms/step -
```

```
loss: 0.0594 - val_loss: 0.1656
Epoch 183/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0503 - val_loss:
0.1652
Epoch 184/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0363 - val_loss:
0.1648
Epoch 185/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0639 - val_loss:
0.1649
Epoch 186/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0588 - val_loss:
0.1651
Epoch 187/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0658 - val_loss:
0.1654
Epoch 188/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0424 - val_loss:
0.1660
Epoch 189/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0470 - val_loss:
0.1667
Epoch 190/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0531 - val_loss:
0.1661
Epoch 191/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0523 - val_loss:
0.1653
Epoch 192/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0507 - val_loss:
0.1662
Epoch 193/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0400 - val_loss:
0.1654
Epoch 194/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0449 - val_loss:
0.1673
Epoch 195/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0799 - val_loss:
0.1646
Epoch 196/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0416 - val_loss:
0.1716
Epoch 197/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0361 - val_loss:
0.1654
Epoch 198/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0673 - val_loss:
```

```
0.1657
Epoch 199/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0371 - val_loss:
0.1673
Epoch 200/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0465 - val_loss:
0.1655
Epoch 201/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0448 - val_loss:
0.1659
Epoch 202/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0388 - val_loss:
0.1671
Epoch 203/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0339 - val_loss:
0.1664
Epoch 204/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0636 - val_loss:
0.1664
Epoch 205/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0594 - val_loss:
0.1665
Epoch 206/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0622 - val_loss:
0.1674
Epoch 207/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0328 - val_loss:
0.1666
Epoch 208/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0369 - val_loss:
0.1682
Epoch 209/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0474 - val_loss:
0.1683
Epoch 210/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0407 - val_loss:
0.1663
Epoch 211/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0418 - val_loss:
0.1676
Epoch 212/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0505 - val_loss:
0.1671
Epoch 213/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0471 - val_loss:
0.1671
Epoch 214/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0425 - val_loss:
```

```
0.1684
Epoch 215/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0452 - val_loss:
0.1685
Epoch 216/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0541 - val_loss:
0.1693
Epoch 217/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0368 - val_loss:
0.1709
Epoch 218/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0437 - val_loss:
0.1708
Epoch 219/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0474 - val_loss:
0.1685
Epoch 220/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0575 - val_loss:
0.1674
Epoch 221/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0515 - val_loss:
0.1719
Epoch 222/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0386 - val_loss:
0.1678
Epoch 223/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0389 - val_loss:
0.1697
Epoch 224/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0453 - val_loss:
0.1698
Epoch 225/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0665 - val_loss:
0.1686
Epoch 226/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0367 - val_loss:
0.1698
Epoch 227/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0432 - val_loss:
0.1719
Epoch 228/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0524 - val_loss:
0.1677
Epoch 229/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0467 - val_loss:
0.1700
Epoch 230/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0375 - val_loss:
```

```
0.1725
Epoch 231/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0475 - val_loss:
0.1687
Epoch 232/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0597 - val_loss:
0.1708
Epoch 233/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0427 - val_loss:
0.1697
Epoch 234/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0389 - val_loss:
0.1699
Epoch 235/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0352 - val_loss:
0.1702
Epoch 236/600
22/22 [==============================] - 0s 16ms/step - loss: 0.0451 - val_loss:
0.1716
Epoch 237/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0469 - val_loss:
0.1699
Epoch 238/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0448 - val_loss:
0.1714
Epoch 239/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0452 - val_loss:
0.1738
Epoch 240/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0387 - val_loss:
0.1736
Epoch 241/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0515 - val_loss:
0.1707
Epoch 242/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0329 - val_loss:
0.1702
Epoch 243/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0500 - val_loss:
0.1724
Epoch 244/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0287 - val_loss:
0.1754
Epoch 245/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0502 - val_loss:
0.1717
Epoch 246/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0409 - val_loss:
```

```
0.1718
Epoch 247/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0514 - val_loss:
0.1721
Epoch 248/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0450 - val_loss:
0.1741
Epoch 249/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0367 - val_loss:
0.1711
Epoch 250/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0506 - val_loss:
0.1716
Epoch 251/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0408 - val_loss:
0.1716
Epoch 252/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0366 - val_loss:
0.1746
Epoch 253/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0327 - val_loss:
0.1724
Epoch 254/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0587 - val_loss:
0.1743
Epoch 255/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0324 - val_loss:
0.1745
Epoch 256/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0381 - val_loss:
0.1740
Epoch 257/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0398 - val_loss:
0.1760
Epoch 258/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0457 - val_loss:
0.1738
Epoch 259/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0466 - val_loss:
0.1745
Epoch 260/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0584 - val_loss:
0.1754
Epoch 261/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0315 - val_loss:
0.1750
Epoch 262/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0336 - val_loss:
```

```
0.1740
Epoch 263/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0520 - val_loss:
0.1750
Epoch 264/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0446 - val_loss:
0.1773
Epoch 265/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0477 - val_loss:
0.1758
Epoch 266/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0489 - val_loss:
0.1730
Epoch 267/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0414 - val_loss:
0.1754
Epoch 268/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0486 - val_loss:
0.1763
Epoch 269/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0397 - val_loss:
0.1793
Epoch 270/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0430 - val_loss:
0.1774
Epoch 271/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0532 - val_loss:
0.1760
Epoch 272/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0386 - val_loss:
0.1778
Epoch 273/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0375 - val_loss:
0.1775
Epoch 274/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0301 - val_loss:
0.1760
Epoch 275/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0350 - val_loss:
0.1788
Epoch 276/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0525 - val_loss:
0.1762
Epoch 277/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0298 - val_loss:
0.1779
Epoch 278/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0573 - val_loss:
```

```
0.1772
Epoch 279/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0310 - val_loss:
0.1810
Epoch 280/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0409 - val_loss:
0.1781
Epoch 281/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0543 - val_loss:
0.1807
Epoch 282/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0398 - val_loss:
0.1797
Epoch 283/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0403 - val_loss:
0.1779
Epoch 284/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0386 - val_loss:
0.1797
Epoch 285/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0438 - val_loss:
0.1785
Epoch 286/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0705 - val_loss:
0.1784
Epoch 287/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0466 - val_loss:
0.1818
Epoch 288/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0346 - val_loss:
0.1778
Epoch 289/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0480 - val_loss:
0.1790
Epoch 290/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0333 - val_loss:
0.1836
Epoch 291/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0433 - val_loss:
0.1781
Epoch 292/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0321 - val_loss:
0.1776
Epoch 293/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0363 - val_loss:
0.1805
Epoch 294/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0456 - val_loss:
```

```
0.1807
Epoch 295/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0363 - val_loss:
0.1819
Epoch 296/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0377 - val_loss:
0.1797
Epoch 297/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0279 - val_loss:
0.1817
Epoch 298/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0754 - val_loss:
0.1815
Epoch 299/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0485 - val_loss:
0.1808
Epoch 300/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0355 - val_loss:
0.1811
Epoch 301/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0323 - val_loss:
0.1811
Epoch 302/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0556 - val_loss:
0.1810
Epoch 303/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0468 - val_loss:
0.1811
Epoch 304/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0579 - val_loss:
0.1810
Epoch 305/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0251 - val_loss:
0.1827
Epoch 306/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0254 - val_loss:
0.1827
Epoch 307/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0341 - val_loss:
0.1825
Epoch 308/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0660 - val_loss:
0.1829
Epoch 309/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0393 - val_loss:
0.1836
Epoch 310/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0457 - val_loss:
```

```
0.1821
Epoch 311/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0406 - val_loss:
0.1799
Epoch 312/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0347 - val_loss:
0.1843
Epoch 313/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0329 - val_loss:
0.1834
Epoch 314/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0451 - val_loss:
0.1824
Epoch 315/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0305 - val_loss:
0.1867
Epoch 316/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0301 - val_loss:
0.1853
Epoch 317/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0356 - val_loss:
0.1841
Epoch 318/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0345 - val_loss:
0.1841
Epoch 319/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0481 - val_loss:
0.1884
Epoch 320/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0383 - val_loss:
0.1840
Epoch 321/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0486 - val_loss:
0.1841
Epoch 322/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0369 - val_loss:
0.1832
Epoch 323/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0327 - val_loss:
0.1848
Epoch 324/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0345 - val_loss:
0.1846
Epoch 325/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0289 - val_loss:
0.1840
Epoch 326/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0465 - val_loss:
```

```
0.1841
Epoch 327/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0410 - val_loss:
0.1847
Epoch 328/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0397 - val_loss:
0.1862
Epoch 329/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0431 - val_loss:
0.1857
Epoch 330/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0543 - val_loss:
0.1873
Epoch 331/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0358 - val_loss:
0.1850
Epoch 332/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0325 - val_loss:
0.1865
Epoch 333/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0408 - val_loss:
0.1845
Epoch 334/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0533 - val_loss:
0.1846
Epoch 335/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0316 - val_loss:
0.1854
Epoch 336/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0276 - val_loss:
0.1887
Epoch 337/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0416 - val_loss:
0.1869
Epoch 338/600
22/22 [==============================] - 0s 22ms/step - loss: 0.0505 - val_loss:
0.1844
Epoch 339/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0418 - val_loss:
0.1884
Epoch 340/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0201 - val_loss:
0.1862
Epoch 341/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0574 - val_loss:
0.1859
Epoch 342/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0364 - val_loss:
```

```
0.1867
Epoch 343/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0345 - val_loss:
0.1866
Epoch 344/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0315 - val_loss:
0.1866
Epoch 345/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0382 - val_loss:
0.1869
Epoch 346/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0350 - val_loss:
0.1879
Epoch 347/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0320 - val_loss:
0.1868
Epoch 348/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0362 - val_loss:
0.1868
Epoch 349/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0376 - val_loss:
0.1896
Epoch 350/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0358 - val_loss:
0.1882
Epoch 351/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0298 - val_loss:
0.1882
Epoch 352/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0263 - val_loss:
0.1870
Epoch 353/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0335 - val_loss:
0.1877
Epoch 354/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0262 - val_loss:
0.1890
Epoch 355/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0281 - val_loss:
0.1900
Epoch 356/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0433 - val_loss:
0.1889
Epoch 357/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0363 - val_loss:
0.1900
Epoch 358/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0330 - val_loss:
```

```
0.1901
Epoch 359/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0395 - val_loss:
0.1908
Epoch 360/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0323 - val_loss:
0.1867
Epoch 361/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0308 - val_loss:
0.1926
Epoch 362/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0275 - val_loss:
0.1891
Epoch 363/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0309 - val_loss:
0.1901
Epoch 364/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0324 - val_loss:
0.1909
Epoch 365/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0357 - val_loss:
0.1885
Epoch 366/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0333 - val_loss:
0.1838
Epoch 367/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0287 - val_loss:
0.1876
Epoch 368/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0283 - val_loss:
0.1880
Epoch 369/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0667 - val_loss:
0.1894
Epoch 370/600
22/22 [==============================] - 1s 38ms/step - loss: 0.0372 - val_loss:
0.1898
Epoch 371/600
22/22 [==============================] - 0s 19ms/step - loss: 0.0443 - val_loss:
0.1883
Epoch 372/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0220 - val_loss:
0.1897
Epoch 373/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0346 - val_loss:
0.1931
Epoch 374/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0397 - val_loss:
```

```
0.1900
Epoch 375/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0257 - val_loss:
0.1898
Epoch 376/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0258 - val_loss:
0.1911
Epoch 377/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0403 - val_loss:
0.1899
Epoch 378/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0448 - val_loss:
0.1895
Epoch 379/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0306 - val_loss:
0.1917
Epoch 380/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0293 - val_loss:
0.1931
Epoch 381/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0368 - val_loss:
0.1932
Epoch 382/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0389 - val_loss:
0.1893
Epoch 383/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0392 - val_loss:
0.1934
Epoch 384/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0377 - val_loss:
0.1936
Epoch 385/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0322 - val_loss:
0.1948
Epoch 386/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0245 - val_loss:
0.1926
Epoch 387/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0256 - val_loss:
0.1917
Epoch 388/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0357 - val_loss:
0.1934
Epoch 389/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0473 - val_loss:
0.1918
Epoch 390/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0262 - val_loss:
```

```
0.1917
Epoch 391/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0271 - val_loss:
0.1931
Epoch 392/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0348 - val_loss:
0.1930
Epoch 393/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0442 - val_loss:
0.1935
Epoch 394/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0447 - val_loss:
0.1925
Epoch 395/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0553 - val_loss:
0.1928
Epoch 396/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0370 - val_loss:
0.1951
Epoch 397/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0339 - val_loss:
0.1931
Epoch 398/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0482 - val_loss:
0.1921
Epoch 399/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0340 - val_loss:
0.1939
Epoch 400/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0361 - val_loss:
0.1935
Epoch 401/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0313 - val_loss:
0.1927
Epoch 402/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0381 - val_loss:
0.1938
Epoch 403/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0446 - val_loss:
0.1941
Epoch 404/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0451 - val_loss:
0.1949
Epoch 405/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0295 - val_loss:
0.1922
Epoch 406/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0305 - val_loss:
```

```
0.1991
Epoch 407/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0533 - val_loss:
0.1952
Epoch 408/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0354 - val_loss:
0.1942
Epoch 409/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0365 - val_loss:
0.1948
Epoch 410/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0331 - val_loss:
0.1956
Epoch 411/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0643 - val_loss:
0.1935
Epoch 412/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0371 - val_loss:
0.1935
Epoch 413/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0200 - val_loss:
0.1924
Epoch 414/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0230 - val_loss:
0.1954
Epoch 415/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0365 - val_loss:
0.1941
Epoch 416/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0372 - val_loss:
0.1934
Epoch 417/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0431 - val_loss:
0.1961
Epoch 418/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0393 - val_loss:
0.1958
Epoch 419/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0378 - val_loss:
0.1941
Epoch 420/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0357 - val_loss:
0.1935
Epoch 421/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0383 - val_loss:
0.1959
Epoch 422/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0296 - val_loss:
```

```
0.1966
Epoch 423/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0212 - val_loss:
0.1950
Epoch 424/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0381 - val_loss:
0.1942
Epoch 425/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0419 - val_loss:
0.1944
Epoch 426/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0282 - val_loss:
0.1977
Epoch 427/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0367 - val_loss:
0.1951
Epoch 428/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0271 - val_loss:
0.1980
Epoch 429/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0393 - val_loss:
0.1940
Epoch 430/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0343 - val_loss:
0.1968
Epoch 431/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0437 - val_loss:
0.1958
Epoch 432/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0432 - val_loss:
0.1951
Epoch 433/600
22/22 [==============================] - 0s 16ms/step - loss: 0.0374 - val_loss:
0.1943
Epoch 434/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0406 - val_loss:
0.1967
Epoch 435/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0323 - val_loss:
0.1948
Epoch 436/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0332 - val_loss:
0.1969
Epoch 437/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0341 - val_loss:
0.1965
Epoch 438/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0339 - val_loss:
```

```
0.1973
Epoch 439/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0291 - val_loss:
0.1963
Epoch 440/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0244 - val_loss:
0.1968
Epoch 441/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0278 - val_loss:
0.1986
Epoch 442/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0434 - val_loss:
0.1997
Epoch 443/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0452 - val_loss:
0.1956
Epoch 444/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0376 - val_loss:
0.1968
Epoch 445/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0341 - val_loss:
0.1997
Epoch 446/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0496 - val_loss:
0.1965
Epoch 447/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0407 - val_loss:
0.1988
Epoch 448/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0498 - val_loss:
0.1969
Epoch 449/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0396 - val_loss:
0.1975
Epoch 450/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0311 - val_loss:
0.1970
Epoch 451/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0361 - val_loss:
0.1978
Epoch 452/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0307 - val_loss:
0.1988
Epoch 453/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0323 - val_loss:
0.1990
Epoch 454/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0286 - val_loss:
```

```
0.2004
Epoch 455/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0278 - val_loss:
0.1976
Epoch 456/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0315 - val_loss:
0.1987
Epoch 457/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0506 - val_loss:
0.1971
Epoch 458/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0518 - val_loss:
0.1999
Epoch 459/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0328 - val_loss:
0.1974
Epoch 460/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0219 - val_loss:
0.2018
Epoch 461/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0228 - val_loss:
0.1999
Epoch 462/600
22/22 [==============================] - 0s 16ms/step - loss: 0.0228 - val_loss:
0.1961
Epoch 463/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0276 - val_loss:
0.2010
Epoch 464/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0217 - val_loss:
0.1999
Epoch 465/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0228 - val_loss:
0.1982
Epoch 466/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0294 - val_loss:
0.2010
Epoch 467/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0398 - val_loss:
0.1997
Epoch 468/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0230 - val_loss:
0.1975
Epoch 469/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0518 - val_loss:
0.2004
Epoch 470/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0286 - val_loss:
```

```
0.1997
Epoch 471/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0323 - val_loss:
0.2034
Epoch 472/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0516 - val_loss:
0.1977
Epoch 473/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0544 - val_loss:
0.1974
Epoch 474/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0376 - val_loss:
0.2044
Epoch 475/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0266 - val_loss:
0.2000
Epoch 476/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0373 - val_loss:
0.1963
Epoch 477/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0214 - val_loss:
0.2020
Epoch 478/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0343 - val_loss:
0.2013
Epoch 479/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0435 - val_loss:
0.2007
Epoch 480/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0368 - val_loss:
0.1977
Epoch 481/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0373 - val_loss:
0.2011
Epoch 482/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0209 - val_loss:
0.2021
Epoch 483/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0278 - val_loss:
0.1986
Epoch 484/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0226 - val_loss:
0.2028
Epoch 485/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0237 - val_loss:
0.1996
Epoch 486/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0252 - val_loss:
```

```
0.2019
Epoch 487/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0267 - val_loss:
0.1995
Epoch 488/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0352 - val_loss:
0.2012
Epoch 489/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0368 - val_loss:
0.2009
Epoch 490/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0314 - val_loss:
0.2020
Epoch 491/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0259 - val_loss:
0.2024
Epoch 492/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0376 - val_loss:
0.2001
Epoch 493/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0309 - val_loss:
0.1995
Epoch 494/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0257 - val_loss:
0.2021
Epoch 495/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0297 - val_loss:
0.2000
Epoch 496/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0422 - val_loss:
0.2022
Epoch 497/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0321 - val_loss:
0.2038
Epoch 498/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0301 - val_loss:
0.2032
Epoch 499/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0374 - val_loss:
0.2026
Epoch 500/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0322 - val_loss:
0.2001
Epoch 501/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0351 - val_loss:
0.2022
Epoch 502/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0349 - val_loss:
```

```
0.2017
Epoch 503/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0357 - val_loss:
0.2046
Epoch 504/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0211 - val_loss:
0.2016
Epoch 505/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0197 - val_loss:
0.2022
Epoch 506/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0663 - val_loss:
0.2024
Epoch 507/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0396 - val_loss:
0.2028
Epoch 508/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0412 - val_loss:
0.2016
Epoch 509/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0293 - val_loss:
0.2026
Epoch 510/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0317 - val_loss:
0.2050
Epoch 511/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0314 - val_loss:
0.2070
Epoch 512/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0263 - val_loss:
0.2013
Epoch 513/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0369 - val_loss:
0.2032
Epoch 514/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0379 - val_loss:
0.2025
Epoch 515/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0326 - val_loss:
0.2044
Epoch 516/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0452 - val_loss:
0.2005
Epoch 517/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0318 - val_loss:
0.2025
Epoch 518/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0253 - val_loss:
```

```
0.2043
Epoch 519/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0236 - val_loss:
0.2051
Epoch 520/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0453 - val_loss:
0.2017
Epoch 521/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0431 - val_loss:
0.2022
Epoch 522/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0378 - val_loss:
0.2058
Epoch 523/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0417 - val_loss:
0.2037
Epoch 524/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0256 - val_loss:
0.2022
Epoch 525/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0277 - val_loss:
0.2039
Epoch 526/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0254 - val_loss:
0.2045
Epoch 527/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0509 - val_loss:
0.2043
Epoch 528/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0384 - val_loss:
0.2054
Epoch 529/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0250 - val_loss:
0.2032
Epoch 530/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0399 - val_loss:
0.2072
Epoch 531/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0290 - val_loss:
0.2037
Epoch 532/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0254 - val_loss:
0.2026
Epoch 533/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0407 - val_loss:
0.2027
Epoch 534/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0272 - val_loss:
```

```
0.2032
Epoch 535/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0355 - val_loss:
0.2030
Epoch 536/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0185 - val_loss:
0.2032
Epoch 537/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0319 - val_loss:
0.2044
Epoch 538/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0480 - val_loss:
0.2043
Epoch 539/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0331 - val_loss:
0.2034
Epoch 540/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0247 - val_loss:
0.2026
Epoch 541/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0258 - val_loss:
0.2023
Epoch 542/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0465 - val_loss:
0.2056
Epoch 543/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0232 - val_loss:
0.2069
Epoch 544/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0182 - val_loss:
0.2028
Epoch 545/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0302 - val_loss:
0.2048
Epoch 546/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0332 - val_loss:
0.2060
Epoch 547/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0194 - val_loss:
0.2040
Epoch 548/600
22/22 [==============================] - 0s 18ms/step - loss: 0.0358 - val_loss:
0.2029
Epoch 549/600
22/22 [==============================] - 1s 32ms/step - loss: 0.0442 - val_loss:
0.2040
Epoch 550/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0240 - val_loss:
```

```
0.2047
Epoch 551/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0361 - val_loss:
0.2050
Epoch 552/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0187 - val_loss:
0.2070
Epoch 553/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0344 - val_loss:
0.2078
Epoch 554/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0219 - val_loss:
0.2069
Epoch 555/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0308 - val_loss:
0.2083
Epoch 556/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0265 - val_loss:
0.2043
Epoch 557/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0298 - val_loss:
0.2053
Epoch 558/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0235 - val_loss:
0.2056
Epoch 559/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0339 - val_loss:
0.2036
Epoch 560/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0245 - val_loss:
0.2033
Epoch 561/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0424 - val_loss:
0.2043
Epoch 562/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0222 - val_loss:
0.2095
Epoch 563/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0348 - val_loss:
0.2030
Epoch 564/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0343 - val_loss:
0.2066
Epoch 565/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0363 - val_loss:
0.2058
Epoch 566/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0331 - val_loss:
```

```
0.2049
Epoch 567/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0358 - val_loss:
0.2049
Epoch 568/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0298 - val_loss:
0.2088
Epoch 569/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0239 - val_loss:
0.2055
Epoch 570/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0327 - val_loss:
0.2064
Epoch 571/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0384 - val_loss:
0.2060
Epoch 572/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0290 - val_loss:
0.2077
Epoch 573/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0440 - val_loss:
0.2053
Epoch 574/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0264 - val_loss:
0.2086
Epoch 575/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0380 - val_loss:
0.2061
Epoch 576/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0251 - val_loss:
0.2052
Epoch 577/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0307 - val_loss:
0.2087
Epoch 578/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0377 - val_loss:
0.2087
Epoch 579/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0626 - val_loss:
0.2071
Epoch 580/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0237 - val_loss:
0.2092
Epoch 581/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0316 - val_loss:
0.2050
Epoch 582/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0422 - val_loss:
```

```
0.2050
Epoch 583/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0200 - val_loss:
0.2074
Epoch 584/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0300 - val_loss:
0.2113
Epoch 585/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0201 - val_loss:
0.2069
Epoch 586/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0221 - val_loss:
0.2091
Epoch 587/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0365 - val_loss:
0.2090
Epoch 588/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0274 - val_loss:
0.2092
Epoch 589/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0385 - val_loss:
0.2076
Epoch 590/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0294 - val_loss:
0.2058
Epoch 591/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0301 - val_loss:
0.2068
Epoch 592/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0372 - val_loss:
0.2067
Epoch 593/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0336 - val_loss:
0.2060
Epoch 594/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0302 - val_loss:
0.2055
Epoch 595/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0252 - val_loss:
0.2076
Epoch 596/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0280 - val_loss:
0.2101
Epoch 597/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0263 - val_loss:
0.2064
Epoch 598/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0315 - val_loss:
```

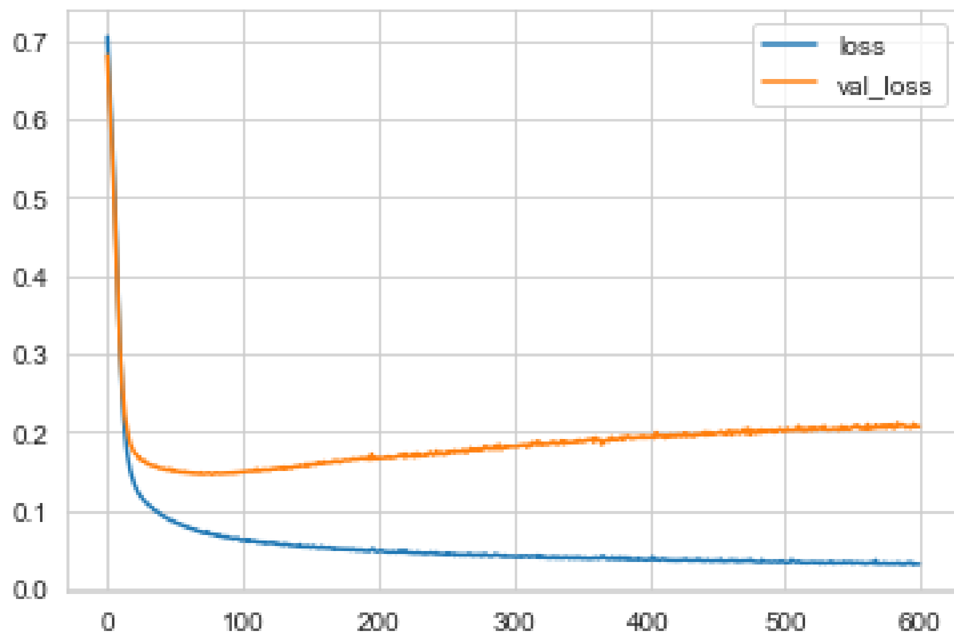
```
0.2069
Epoch 599/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0422 - val_loss:
0.2067
Epoch 600/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0415 - val_loss:
0.2071
```

[23]:
```
<tensorflow.python.keras.callbacks.History at 0x15fae9e7ac8>
```

Analyze the Loss - Model History

[24]:
```python
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

[24]:
```
<AxesSubplot:>
```



The above plot interpretes that we have trained our data alot! leads to "Over fitting".

- Let's use early stopping to track the val_loss and stop training once it begins increasing to a limit. #### 4.2.2 TRAIL -02 #### Using Early Stopping: Stop training when a monitored quantity has stopped improving.

[25]:
```python
model = Sequential()
model.add(Dense(units=16,activation='relu'))
model.add(Dense(units=8,activation='relu'))
model.add(Dense(units=1,activation='sigmoid'))
```

```
model.compile(loss='binary_crossentropy', optimizer='adam')
```

[26]:
```
early_stop = EarlyStopping(monitor='val_loss', mode='min', verbose=1,␣
↪patience=25)
```

[27]:
```
model.fit(x=X_train,
          y=y_train,
          epochs=600,
          validation_data=(X_test, y_test), verbose=1,
          callbacks=[early_stop]
          )
```

```
Epoch 1/600
22/22 [==============================] - 1s 15ms/step - loss: 0.7424 - val_loss:
0.6965
Epoch 2/600
22/22 [==============================] - 0s 5ms/step - loss: 0.6865 - val_loss:
0.6721
Epoch 3/600
22/22 [==============================] - 0s 5ms/step - loss: 0.6602 - val_loss:
0.6506
Epoch 4/600
22/22 [==============================] - 0s 6ms/step - loss: 0.6377 - val_loss:
0.6263
Epoch 5/600
22/22 [==============================] - 0s 5ms/step - loss: 0.6126 - val_loss:
0.5961
Epoch 6/600
22/22 [==============================] - 0s 6ms/step - loss: 0.5824 - val_loss:
0.5581
Epoch 7/600
22/22 [==============================] - 0s 6ms/step - loss: 0.5346 - val_loss:
0.5107
Epoch 8/600
22/22 [==============================] - 0s 5ms/step - loss: 0.4839 - val_loss:
0.4524
Epoch 9/600
22/22 [==============================] - 0s 5ms/step - loss: 0.4094 - val_loss:
0.3921
Epoch 10/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3587 - val_loss:
0.3436
Epoch 11/600
22/22 [==============================] - 0s 10ms/step - loss: 0.3013 - val_loss:
0.3055
Epoch 12/600
22/22 [==============================] - 0s 20ms/step - loss: 0.2405 - val_loss:
```

```
0.2751
Epoch 13/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2263 - val_loss:
0.2551
Epoch 14/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1926 - val_loss:
0.2390
Epoch 15/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1907 - val_loss:
0.2284
Epoch 16/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1923 - val_loss:
0.2215
Epoch 17/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1587 - val_loss:
0.2138
Epoch 18/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1532 - val_loss:
0.2107
Epoch 19/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1490 - val_loss:
0.2041
Epoch 20/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1175 - val_loss:
0.2009
Epoch 21/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1294 - val_loss:
0.1994
Epoch 22/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1615 - val_loss:
0.1957
Epoch 23/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1471 - val_loss:
0.1933
Epoch 24/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1326 - val_loss:
0.1913
Epoch 25/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1298 - val_loss:
0.1900
Epoch 26/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1195 - val_loss:
0.1884
Epoch 27/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1338 - val_loss:
0.1866
Epoch 28/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1070 - val_loss:
```

```
0.1853
Epoch 29/600
22/22 [==============================] - 0s 12ms/step - loss: 0.1314 - val_loss:
0.1850
Epoch 30/600
22/22 [==============================] - 0s 12ms/step - loss: 0.1297 - val_loss:
0.1830
Epoch 31/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1470 - val_loss:
0.1817
Epoch 32/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1117 - val_loss:
0.1807
Epoch 33/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1015 - val_loss:
0.1799
Epoch 34/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1178 - val_loss:
0.1794
Epoch 35/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0970 - val_loss:
0.1782
Epoch 36/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0954 - val_loss:
0.1772
Epoch 37/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0937 - val_loss:
0.1758
Epoch 38/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1035 - val_loss:
0.1755
Epoch 39/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1159 - val_loss:
0.1746
Epoch 40/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1310 - val_loss:
0.1733
Epoch 41/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0822 - val_loss:
0.1726
Epoch 42/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0996 - val_loss:
0.1714
Epoch 43/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0950 - val_loss:
0.1706
Epoch 44/600
22/22 [==============================] - 0s 12ms/step - loss: 0.1128 - val_loss:
```

```
0.1702
Epoch 45/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0947 - val_loss:
0.1700
Epoch 46/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1104 - val_loss:
0.1693
Epoch 47/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0683 - val_loss:
0.1688
Epoch 48/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1133 - val_loss:
0.1672
Epoch 49/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1021 - val_loss:
0.1665
Epoch 50/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1179 - val_loss:
0.1662
Epoch 51/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0797 - val_loss:
0.1658
Epoch 52/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0783 - val_loss:
0.1651
Epoch 53/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0874 - val_loss:
0.1640
Epoch 54/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0821 - val_loss:
0.1634
Epoch 55/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0839 - val_loss:
0.1633
Epoch 56/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0909 - val_loss:
0.1625
Epoch 57/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0825 - val_loss:
0.1621
Epoch 58/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0811 - val_loss:
0.1617
Epoch 59/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0795 - val_loss:
0.1613
Epoch 60/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0982 - val_loss:
```

```
0.1603
Epoch 61/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0956 - val_loss:
0.1606
Epoch 62/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0818 - val_loss:
0.1595
Epoch 63/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1019 - val_loss:
0.1592
Epoch 64/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1071 - val_loss:
0.1587
Epoch 65/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0976 - val_loss:
0.1586
Epoch 66/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0772 - val_loss:
0.1583
Epoch 67/600
22/22 [==============================] - 0s 10ms/step - loss: 0.0763 - val_loss:
0.1573
Epoch 68/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0806 - val_loss:
0.1573
Epoch 69/600
22/22 [==============================] - 0s 16ms/step - loss: 0.0596 - val_loss:
0.1570
Epoch 70/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0942 - val_loss:
0.1571
Epoch 71/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0742 - val_loss:
0.1562
Epoch 72/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0735 - val_loss:
0.1599
Epoch 73/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0717 - val_loss:
0.1556
Epoch 74/600
22/22 [==============================] - 0s 11ms/step - loss: 0.0692 - val_loss:
0.1553
Epoch 75/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0854 - val_loss:
0.1545
Epoch 76/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0709 - val_loss:
```

```
0.1543
Epoch 77/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0798 - val_loss:
0.1542
Epoch 78/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0764 - val_loss:
0.1534
Epoch 79/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0756 - val_loss:
0.1533
Epoch 80/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0853 - val_loss:
0.1537
Epoch 81/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0798 - val_loss:
0.1531
Epoch 82/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0668 - val_loss:
0.1528
Epoch 83/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0874 - val_loss:
0.1522
Epoch 84/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0827 - val_loss:
0.1525
Epoch 85/600
22/22 [==============================] - 0s 4ms/step - loss: 0.0862 - val_loss:
0.1529
Epoch 86/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0691 - val_loss:
0.1522
Epoch 87/600
22/22 [==============================] - 0s 14ms/step - loss: 0.0932 - val_loss:
0.1531
Epoch 88/600
22/22 [==============================] - 0s 15ms/step - loss: 0.0807 - val_loss:
0.1520
Epoch 89/600
22/22 [==============================] - 0s 18ms/step - loss: 0.0800 - val_loss:
0.1516
Epoch 90/600
22/22 [==============================] - 0s 12ms/step - loss: 0.0733 - val_loss:
0.1520
Epoch 91/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0909 - val_loss:
0.1521
Epoch 92/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0652 - val_loss:
```

```
0.1507
Epoch 93/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0690 - val_loss:
0.1509
Epoch 94/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0736 - val_loss:
0.1517
Epoch 95/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0726 - val_loss:
0.1504
Epoch 96/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0789 - val_loss:
0.1504
Epoch 97/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0696 - val_loss:
0.1516
Epoch 98/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0692 - val_loss:
0.1513
Epoch 99/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0819 - val_loss:
0.1501
Epoch 100/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0663 - val_loss:
0.1516
Epoch 101/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0803 - val_loss:
0.1511
Epoch 102/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0911 - val_loss:
0.1504
Epoch 103/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0891 - val_loss:
0.1516
Epoch 104/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0871 - val_loss:
0.1511
Epoch 105/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0636 - val_loss:
0.1509
Epoch 106/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0671 - val_loss:
0.1509
Epoch 107/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0714 - val_loss:
0.1506
Epoch 108/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0657 - val_loss:
```

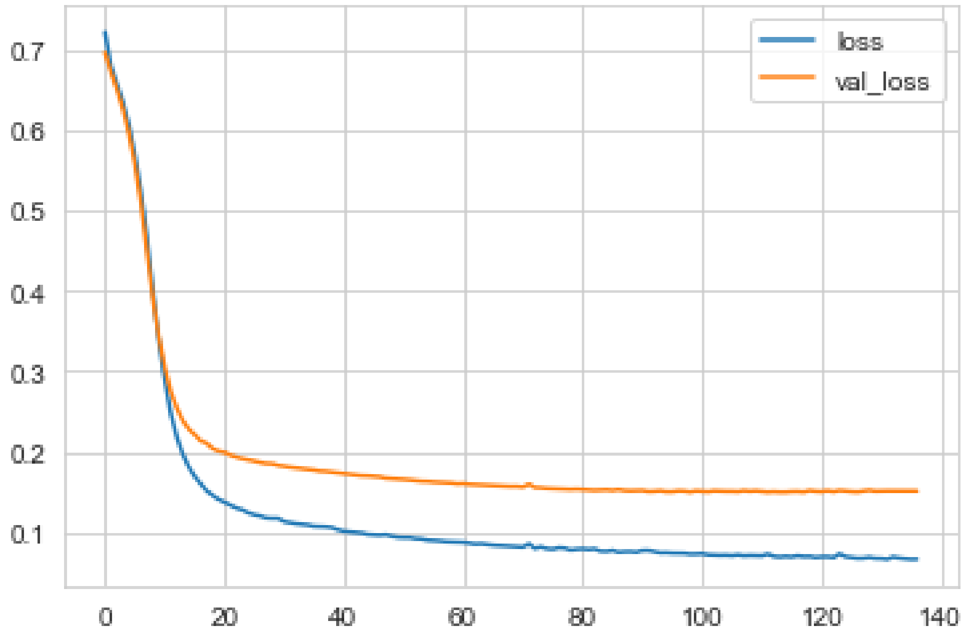
```
0.1518
Epoch 109/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0720 - val_loss:
0.1510
Epoch 110/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0860 - val_loss:
0.1516
Epoch 111/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0627 - val_loss:
0.1506
Epoch 112/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0606 - val_loss:
0.1500
Epoch 113/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0756 - val_loss:
0.1505
Epoch 114/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0571 - val_loss:
0.1500
Epoch 115/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0505 - val_loss:
0.1500
Epoch 116/600
22/22 [==============================] - 0s 9ms/step - loss: 0.0636 - val_loss:
0.1506
Epoch 117/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0857 - val_loss:
0.1508
Epoch 118/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0740 - val_loss:
0.1501
Epoch 119/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0525 - val_loss:
0.1519
Epoch 120/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0837 - val_loss:
0.1510
Epoch 121/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0623 - val_loss:
0.1505
Epoch 122/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0795 - val_loss:
0.1518
Epoch 123/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0551 - val_loss:
0.1505
Epoch 124/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0626 - val_loss:
```

```
0.1520
Epoch 125/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0719 - val_loss:
0.1513
Epoch 126/600
22/22 [==============================] - 0s 7ms/step - loss: 0.0676 - val_loss:
0.1507
Epoch 127/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0571 - val_loss:
0.1502
Epoch 128/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0626 - val_loss:
0.1513
Epoch 129/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0584 - val_loss:
0.1524
Epoch 130/600
22/22 [==============================] - 0s 13ms/step - loss: 0.0594 - val_loss:
0.1511
Epoch 131/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0693 - val_loss:
0.1514
Epoch 132/600
22/22 [==============================] - 0s 8ms/step - loss: 0.0476 - val_loss:
0.1514
Epoch 133/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0546 - val_loss:
0.1515
Epoch 134/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0764 - val_loss:
0.1513
Epoch 135/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0823 - val_loss:
0.1513
Epoch 136/600
22/22 [==============================] - 0s 5ms/step - loss: 0.0486 - val_loss:
0.1516
Epoch 137/600
22/22 [==============================] - 0s 6ms/step - loss: 0.0522 - val_loss:
0.1513
Epoch 00137: early stopping
```

[27]:
```
<tensorflow.python.keras.callbacks.History at 0x15fae878cf8>
```

[28]:
```
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

[28]: <AxesSubplot:>



Training Stopped at 168th Epoch. We can see our traing & Val_loss are started decreasing and become constant after 125th Epoch! ***Let's add "Dropout Layers" to prevent over fitting*** * Dropout layers essentially turn off a percent of neurons randomly

4.2.3 TRAIL - 03

We have given Dropout rate = 0.5, that means Half the neurons in the layer are going to be turned off randomly for each batch or epoch of the training.

[29]:
```
model = Sequential()
model.add(Dense(units=16,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(units=8,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(units=1,activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam')
```

[30]:
```
model.fit(x=X_train,
          y=y_train,
          epochs=600,
          validation_data=(X_test, y_test), verbose=1,
          callbacks=[early_stop]
```

```
        )
```

```
Epoch 1/600
22/22 [==============================] - 1s 16ms/step - loss: 0.7102 - val_loss:
0.6809
Epoch 2/600
22/22 [==============================] - 0s 18ms/step - loss: 0.7046 - val_loss:
0.6747
Epoch 3/600
22/22 [==============================] - 0s 10ms/step - loss: 0.6842 - val_loss:
0.6674
Epoch 4/600
22/22 [==============================] - 0s 8ms/step - loss: 0.6792 - val_loss:
0.6588
Epoch 5/600
22/22 [==============================] - 0s 8ms/step - loss: 0.6642 - val_loss:
0.6489
Epoch 6/600
22/22 [==============================] - 0s 8ms/step - loss: 0.6693 - val_loss:
0.6367
Epoch 7/600
22/22 [==============================] - 0s 13ms/step - loss: 0.6378 - val_loss:
0.6243
Epoch 8/600
22/22 [==============================] - 0s 9ms/step - loss: 0.6312 - val_loss:
0.6109
Epoch 9/600
22/22 [==============================] - 0s 7ms/step - loss: 0.6413 - val_loss:
0.6001
Epoch 10/600
22/22 [==============================] - 0s 8ms/step - loss: 0.6115 - val_loss:
0.5864
Epoch 11/600
22/22 [==============================] - 0s 6ms/step - loss: 0.6222 - val_loss:
0.5750
Epoch 12/600
22/22 [==============================] - 0s 7ms/step - loss: 0.6037 - val_loss:
0.5544
Epoch 13/600
22/22 [==============================] - 0s 6ms/step - loss: 0.5830 - val_loss:
0.5330
Epoch 14/600
22/22 [==============================] - 0s 7ms/step - loss: 0.5748 - val_loss:
0.5104
Epoch 15/600
22/22 [==============================] - 0s 6ms/step - loss: 0.5349 - val_loss:
0.4839
```

```
Epoch 16/600
22/22 [==============================] - 0s 8ms/step - loss: 0.5289 - val_loss:
0.4554
Epoch 17/600
22/22 [==============================] - 0s 9ms/step - loss: 0.5225 - val_loss:
0.4298
Epoch 18/600
22/22 [==============================] - 0s 7ms/step - loss: 0.5108 - val_loss:
0.4129
Epoch 19/600
22/22 [==============================] - 0s 7ms/step - loss: 0.5151 - val_loss:
0.3915
Epoch 20/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4585 - val_loss:
0.3662
Epoch 21/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4363 - val_loss:
0.3424
Epoch 22/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4329 - val_loss:
0.3204
Epoch 23/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4597 - val_loss:
0.3098
Epoch 24/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4174 - val_loss:
0.2985
Epoch 25/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3735 - val_loss:
0.2818
Epoch 26/600
22/22 [==============================] - 0s 6ms/step - loss: 0.4061 - val_loss:
0.2690
Epoch 27/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3327 - val_loss:
0.2572
Epoch 28/600
22/22 [==============================] - 0s 10ms/step - loss: 0.3588 - val_loss:
0.2517
Epoch 29/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3506 - val_loss:
0.2404
Epoch 30/600
22/22 [==============================] - 0s 8ms/step - loss: 0.3431 - val_loss:
0.2341
Epoch 31/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3076 - val_loss:
0.2254
```

```
Epoch 32/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2852 - val_loss:
0.2193
Epoch 33/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3311 - val_loss:
0.2175
Epoch 34/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3169 - val_loss:
0.2133
Epoch 35/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3102 - val_loss:
0.2111
Epoch 36/600
22/22 [==============================] - 0s 7ms/step - loss: 0.3301 - val_loss:
0.2075
Epoch 37/600
22/22 [==============================] - 0s 8ms/step - loss: 0.3141 - val_loss:
0.2045
Epoch 38/600
22/22 [==============================] - 0s 16ms/step - loss: 0.3078 - val_loss:
0.2016
Epoch 39/600
22/22 [==============================] - 0s 8ms/step - loss: 0.3220 - val_loss:
0.2003
Epoch 40/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2535 - val_loss:
0.1956
Epoch 41/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2881 - val_loss:
0.1950
Epoch 42/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2911 - val_loss:
0.1935
Epoch 43/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2729 - val_loss:
0.1924
Epoch 44/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2909 - val_loss:
0.1903
Epoch 45/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2630 - val_loss:
0.1888
Epoch 46/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2610 - val_loss:
0.1886
Epoch 47/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2665 - val_loss:
0.1871
```

```
Epoch 48/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2621 - val_loss:
0.1856
Epoch 49/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2310 - val_loss:
0.1850
Epoch 50/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2589 - val_loss:
0.1847
Epoch 51/600
22/22 [==============================] - 0s 6ms/step - loss: 0.3337 - val_loss:
0.1851
Epoch 52/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2253 - val_loss:
0.1840
Epoch 53/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2428 - val_loss:
0.1814
Epoch 54/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2413 - val_loss:
0.1800
Epoch 55/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2446 - val_loss:
0.1789
Epoch 56/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2670 - val_loss:
0.1791
Epoch 57/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2530 - val_loss:
0.1790
Epoch 58/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2203 - val_loss:
0.1781
Epoch 59/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2574 - val_loss:
0.1778
Epoch 60/600
22/22 [==============================] - 0s 10ms/step - loss: 0.2293 - val_loss:
0.1765
Epoch 61/600
22/22 [==============================] - 0s 9ms/step - loss: 0.2439 - val_loss:
0.1766
Epoch 62/600
22/22 [==============================] - 0s 8ms/step - loss: 0.2384 - val_loss:
0.1781
Epoch 63/600
22/22 [==============================] - 0s 8ms/step - loss: 0.2368 - val_loss:
0.1779
```

```
Epoch 64/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2292 - val_loss:
0.1767
Epoch 65/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2281 - val_loss:
0.1764
Epoch 66/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2180 - val_loss:
0.1754
Epoch 67/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2071 - val_loss:
0.1748
Epoch 68/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2316 - val_loss:
0.1749
Epoch 69/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2534 - val_loss:
0.1753
Epoch 70/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2567 - val_loss:
0.1751
Epoch 71/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2010 - val_loss:
0.1737
Epoch 72/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2470 - val_loss:
0.1733
Epoch 73/600
22/22 [==============================] - 0s 9ms/step - loss: 0.2178 - val_loss:
0.1734
Epoch 74/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2451 - val_loss:
0.1727
Epoch 75/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1942 - val_loss:
0.1724
Epoch 76/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2534 - val_loss:
0.1726
Epoch 77/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2480 - val_loss:
0.1725
Epoch 78/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1982 - val_loss:
0.1720
Epoch 79/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2163 - val_loss:
0.1713
```

```
Epoch 80/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2215 - val_loss:
0.1712
Epoch 81/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1965 - val_loss:
0.1707
Epoch 82/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2243 - val_loss:
0.1747
Epoch 83/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2231 - val_loss:
0.1710
Epoch 84/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2224 - val_loss:
0.1715
Epoch 85/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2347 - val_loss:
0.1705
Epoch 86/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2423 - val_loss:
0.1703
Epoch 87/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2545 - val_loss:
0.1699
Epoch 88/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2219 - val_loss:
0.1694
Epoch 89/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2214 - val_loss:
0.1710
Epoch 90/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1872 - val_loss:
0.1710
Epoch 91/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2109 - val_loss:
0.1720
Epoch 92/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1925 - val_loss:
0.1723
Epoch 93/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2366 - val_loss:
0.1718
Epoch 94/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2083 - val_loss:
0.1727
Epoch 95/600
22/22 [==============================] - 0s 15ms/step - loss: 0.2191 - val_loss:
0.1727
```

```
Epoch 96/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2204 - val_loss:
0.1712
Epoch 97/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2021 - val_loss:
0.1724
Epoch 98/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2033 - val_loss:
0.1712
Epoch 99/600
22/22 [==============================] - 0s 5ms/step - loss: 0.2137 - val_loss:
0.1709
Epoch 100/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2057 - val_loss:
0.1712
Epoch 101/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2245 - val_loss:
0.1710
Epoch 102/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2011 - val_loss:
0.1727
Epoch 103/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1900 - val_loss:
0.1731
Epoch 104/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2223 - val_loss:
0.1726
Epoch 105/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2210 - val_loss:
0.1710
Epoch 106/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2115 - val_loss:
0.1753
Epoch 107/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1897 - val_loss:
0.1724
Epoch 108/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2194 - val_loss:
0.1706
Epoch 109/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1954 - val_loss:
0.1688
Epoch 110/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2037 - val_loss:
0.1680
Epoch 111/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1885 - val_loss:
0.1696
```

```
Epoch 112/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2256 - val_loss:
0.1707
Epoch 113/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1965 - val_loss:
0.1686
Epoch 114/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1994 - val_loss:
0.1695
Epoch 115/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1815 - val_loss:
0.1695
Epoch 116/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2220 - val_loss:
0.1667
Epoch 117/600
22/22 [==============================] - 0s 7ms/step - loss: 0.2166 - val_loss:
0.1693
Epoch 118/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1895 - val_loss:
0.1688
Epoch 119/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1773 - val_loss:
0.1691
Epoch 120/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2161 - val_loss:
0.1688
Epoch 121/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1527 - val_loss:
0.1682
Epoch 122/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1579 - val_loss:
0.1707
Epoch 123/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1855 - val_loss:
0.1718
Epoch 124/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1977 - val_loss:
0.1720
Epoch 125/600
22/22 [==============================] - 0s 8ms/step - loss: 0.2281 - val_loss:
0.1674
Epoch 126/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1866 - val_loss:
0.1701
Epoch 127/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1829 - val_loss:
0.1659
```

```
Epoch 128/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1841 - val_loss:
0.1625
Epoch 129/600
22/22 [==============================] - 0s 13ms/step - loss: 0.2069 - val_loss:
0.1634
Epoch 130/600
22/22 [==============================] - 0s 11ms/step - loss: 0.2280 - val_loss:
0.1634
Epoch 131/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1733 - val_loss:
0.1646
Epoch 132/600
22/22 [==============================] - 0s 17ms/step - loss: 0.2125 - val_loss:
0.1624
Epoch 133/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1948 - val_loss:
0.1664
Epoch 134/600
22/22 [==============================] - 0s 9ms/step - loss: 0.2079 - val_loss:
0.1656
Epoch 135/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1624 - val_loss:
0.1651
Epoch 136/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1959 - val_loss:
0.1673
Epoch 137/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1957 - val_loss:
0.1658
Epoch 138/600
22/22 [==============================] - 0s 12ms/step - loss: 0.2054 - val_loss:
0.1663
Epoch 139/600
22/22 [==============================] - 0s 10ms/step - loss: 0.1591 - val_loss:
0.1692
Epoch 140/600
22/22 [==============================] - 0s 15ms/step - loss: 0.2155 - val_loss:
0.1745
Epoch 141/600
22/22 [==============================] - 0s 10ms/step - loss: 0.1798 - val_loss:
0.1663
Epoch 142/600
22/22 [==============================] - 0s 16ms/step - loss: 0.1609 - val_loss:
0.1634
Epoch 143/600
22/22 [==============================] - 0s 9ms/step - loss: 0.2050 - val_loss:
0.1625
```

```
Epoch 144/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1729 - val_loss:
0.1641
Epoch 145/600
22/22 [==============================] - 0s 8ms/step - loss: 0.2135 - val_loss:
0.1610
Epoch 146/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2076 - val_loss:
0.1638
Epoch 147/600
22/22 [==============================] - 0s 6ms/step - loss: 0.2159 - val_loss:
0.1673
Epoch 148/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1799 - val_loss:
0.1696
Epoch 149/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1784 - val_loss:
0.1690
Epoch 150/600
22/22 [==============================] - 1s 29ms/step - loss: 0.1850 - val_loss:
0.1664
Epoch 151/600
22/22 [==============================] - 0s 15ms/step - loss: 0.1764 - val_loss:
0.1677
Epoch 152/600
22/22 [==============================] - 0s 19ms/step - loss: 0.1651 - val_loss:
0.1702
Epoch 153/600
22/22 [==============================] - 0s 13ms/step - loss: 0.1763 - val_loss:
0.1680
Epoch 154/600
22/22 [==============================] - 0s 14ms/step - loss: 0.1721 - val_loss:
0.1684
Epoch 155/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1689 - val_loss:
0.1713
Epoch 156/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1708 - val_loss:
0.1660
Epoch 157/600
22/22 [==============================] - 0s 13ms/step - loss: 0.2038 - val_loss:
0.1684
Epoch 158/600
22/22 [==============================] - 0s 12ms/step - loss: 0.1554 - val_loss:
0.1736
Epoch 159/600
22/22 [==============================] - 0s 10ms/step - loss: 0.1644 - val_loss:
0.1702
```

```
Epoch 160/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1854 - val_loss:
0.1695
Epoch 161/600
22/22 [==============================] - 0s 9ms/step - loss: 0.2067 - val_loss:
0.1680
Epoch 162/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1675 - val_loss:
0.1649
Epoch 163/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1691 - val_loss:
0.1612
Epoch 164/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1827 - val_loss:
0.1613
Epoch 165/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1845 - val_loss:
0.1613
Epoch 166/600
22/22 [==============================] - 0s 19ms/step - loss: 0.1861 - val_loss:
0.1625
Epoch 167/600
22/22 [==============================] - 0s 22ms/step - loss: 0.1680 - val_loss:
0.1636
Epoch 168/600
22/22 [==============================] - 0s 15ms/step - loss: 0.1698 - val_loss:
0.1626
Epoch 169/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1506 - val_loss:
0.1660
Epoch 170/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1545 - val_loss:
0.1607
Epoch 171/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1840 - val_loss:
0.1618
Epoch 172/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1393 - val_loss:
0.1613
Epoch 173/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1435 - val_loss:
0.1639
Epoch 174/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1621 - val_loss:
0.1636
Epoch 175/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1320 - val_loss:
0.1660
```

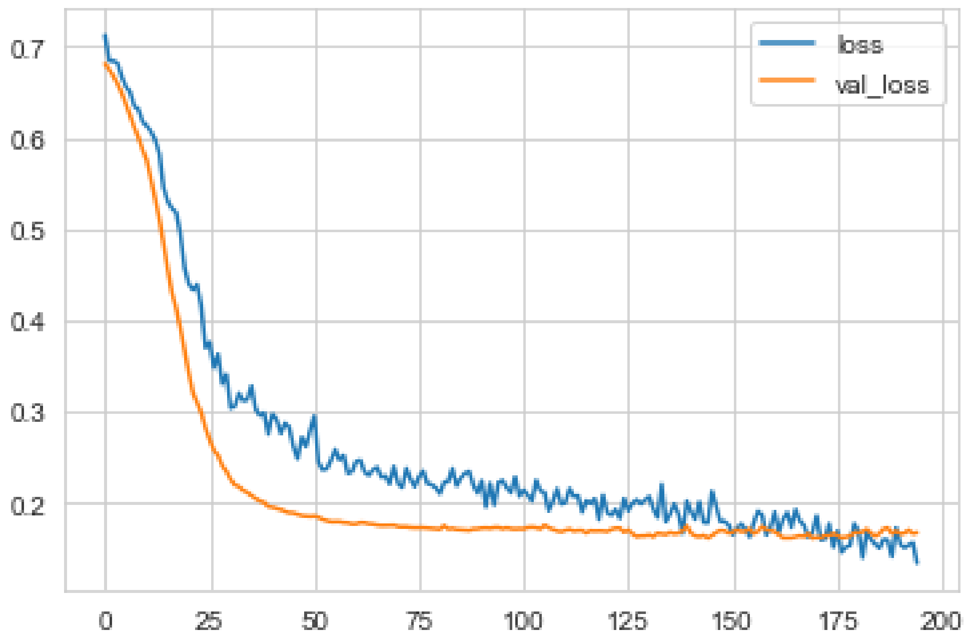
```
Epoch 176/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1923 - val_loss:
0.1639
Epoch 177/600
22/22 [==============================] - 0s 5ms/step - loss: 0.1519 - val_loss:
0.1614
Epoch 178/600
22/22 [==============================] - 0s 4ms/step - loss: 0.1468 - val_loss:
0.1620
Epoch 179/600
22/22 [==============================] - 0s 15ms/step - loss: 0.1560 - val_loss:
0.1634
Epoch 180/600
22/22 [==============================] - 1s 27ms/step - loss: 0.1755 - val_loss:
0.1671
Epoch 181/600
22/22 [==============================] - 0s 17ms/step - loss: 0.1334 - val_loss:
0.1669
Epoch 182/600
22/22 [==============================] - 0s 7ms/step - loss: 0.1414 - val_loss:
0.1679
Epoch 183/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1798 - val_loss:
0.1709
Epoch 184/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1720 - val_loss:
0.1666
Epoch 185/600
22/22 [==============================] - 0s 8ms/step - loss: 0.1379 - val_loss:
0.1631
Epoch 186/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1503 - val_loss:
0.1658
Epoch 187/600
22/22 [==============================] - 0s 6ms/step - loss: 0.1687 - val_loss:
0.1711
Epoch 188/600
22/22 [==============================] - 1s 25ms/step - loss: 0.1537 - val_loss:
0.1723
Epoch 189/600
22/22 [==============================] - 0s 17ms/step - loss: 0.1468 - val_loss:
0.1659
Epoch 190/600
22/22 [==============================] - 1s 24ms/step - loss: 0.1621 - val_loss:
0.1688
Epoch 191/600
22/22 [==============================] - 0s 9ms/step - loss: 0.1489 - val_loss:
0.1656
```

```
Epoch 192/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1371 - val_loss:
0.1664
Epoch 193/600
22/22 [==============================] - 0s 11ms/step - loss: 0.1618 - val_loss:
0.1700
Epoch 194/600
22/22 [==============================] - 0s 13ms/step - loss: 0.2005 - val_loss:
0.1659
Epoch 195/600
22/22 [==============================] - 0s 16ms/step - loss: 0.1271 - val_loss:
0.1671
Epoch 00195: early stopping
```

[30]: <tensorflow.python.keras.callbacks.History at 0x15fb2485be0>

[31]:
```
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

[31]: <AxesSubplot:>



From the plot we can see that, Training loss and Validation loss are both quickly going down and eventually flattening nearly at the same rate. This is much improved than the earlier.

0.5 5. Calculate Accuracy Measures

[32]:
```
predictions = model.predict_classes(X_test)
```

[33]:
```
print(classification_report(y_test,predictions))
```

```
              precision    recall  f1-score   support

           0       0.93      0.97      0.95       146
           1       0.97      0.93      0.95       154

    accuracy                           0.95       300
   macro avg       0.95      0.95      0.95       300
weighted avg       0.95      0.95      0.95       300
```

[34]:
```
print(confusion_matrix(y_test,predictions))
```

```
[[141   5]
 [ 11 143]]
```

Justification :

- Initially we have trained the data by giving same inputs for 600 epochs and we observed over fitting.
- Then we applied ***Early Stopping*** method which stoped training when a monitored quantity has stopped improving after 168th Epoch, for this we have given the parameter patience=25 which run for extra 25 epoch even after identifying the best val_loss.
- Finally we have applied ***Dropout rate*** to get more precise output, with this configuration we got an accuracy of ***95%***.