Importing the required libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
import tensorflow as tf
import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
```

Loading the dataset on colab

```
df = pd.read_csv('/content/drive/MyDrive/Crop Production data.csv')
```

Displaying the first 10 rows of the dataset

```
df.head(10)
```


```
{"type":"dataframe","variable_name":"df"}
```


Info of the dataset

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246091 entries, 0 to 246090
Data columns (total 7 columns):
 #   Column         Non-Null Count   Dtype  
---  ------         --------------   -----  
 0   State_Name     246091 non-null  object 
 1   District_Name  246091 non-null  object 
 2   Crop_Year      246091 non-null  int64  
 3   Season         246091 non-null  object 
 4   Crop           246091 non-null  object 
 5   Area           246091 non-null  float64
 6   Production     242361 non-null  float64
dtypes: float64(2), int64(1), object(4)
memory usage: 13.1+ MB
```

Finding the mean of the production

```
mean_production = df['Production'].mean()

mean_production

582503.4422509808
```

Filling the null values with the mean of production

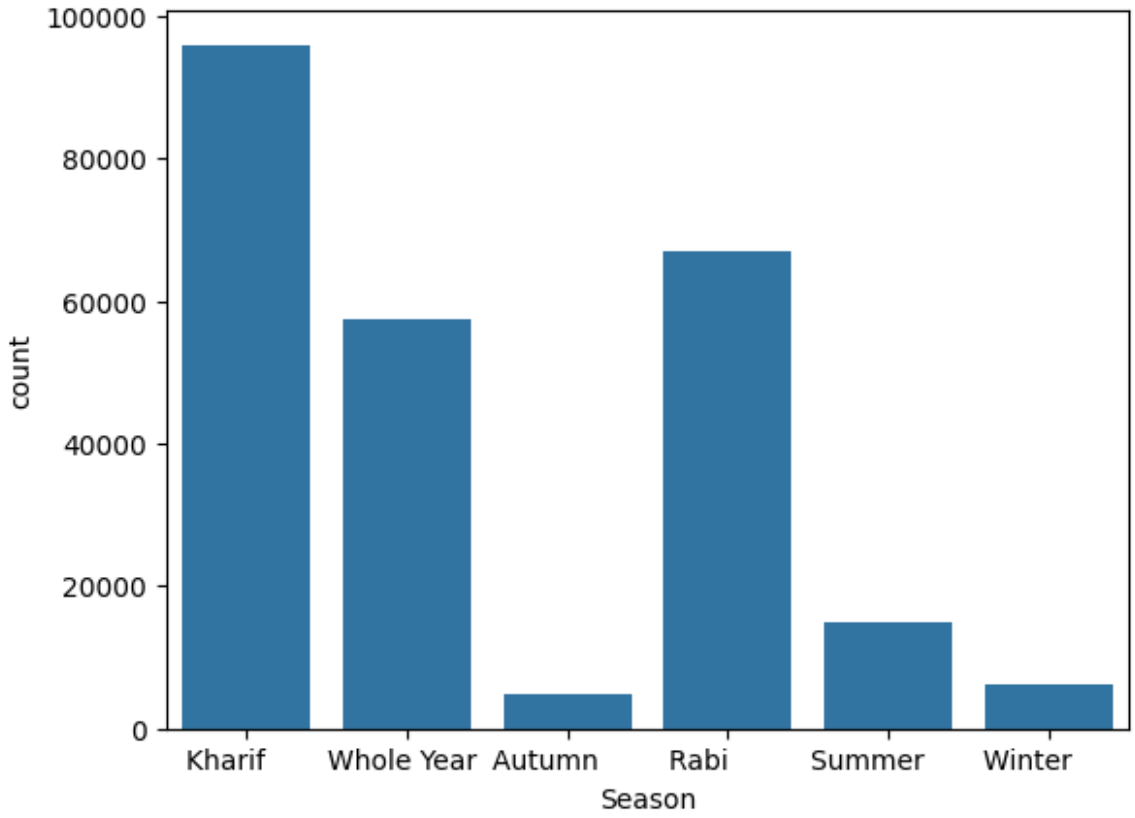
```
df['Production'] = df['Production'].fillna(value = mean_production)
```

Info after filling the null values

```
df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246091 entries, 0 to 246090
Data columns (total 7 columns):
 #   Column         Non-Null Count   Dtype  
---  ------         --------------   -----  
 0   State_Name     246091 non-null  object 
 1   District_Name  246091 non-null  object 
 2   Crop_Year      246091 non-null  int64  
 3   Season         246091 non-null  object 
 4   Crop           246091 non-null  object 
 5   Area           246091 non-null  float64
 6   Production     246091 non-null  float64
dtypes: float64(2), int64(1), object(4)
memory usage: 13.1+ MB
```

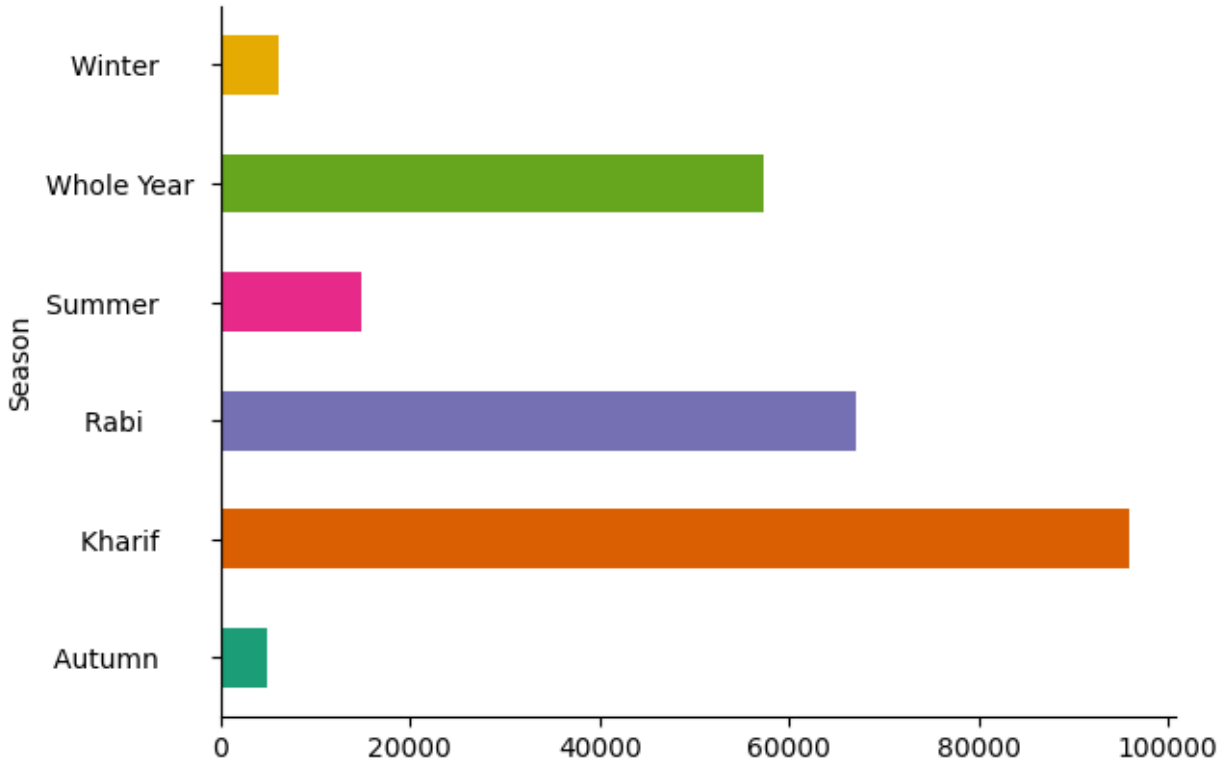
Countplot of the season

```
sns.countplot(x = 'Season', data = df)

<Axes: xlabel='Season', ylabel='count'>
```



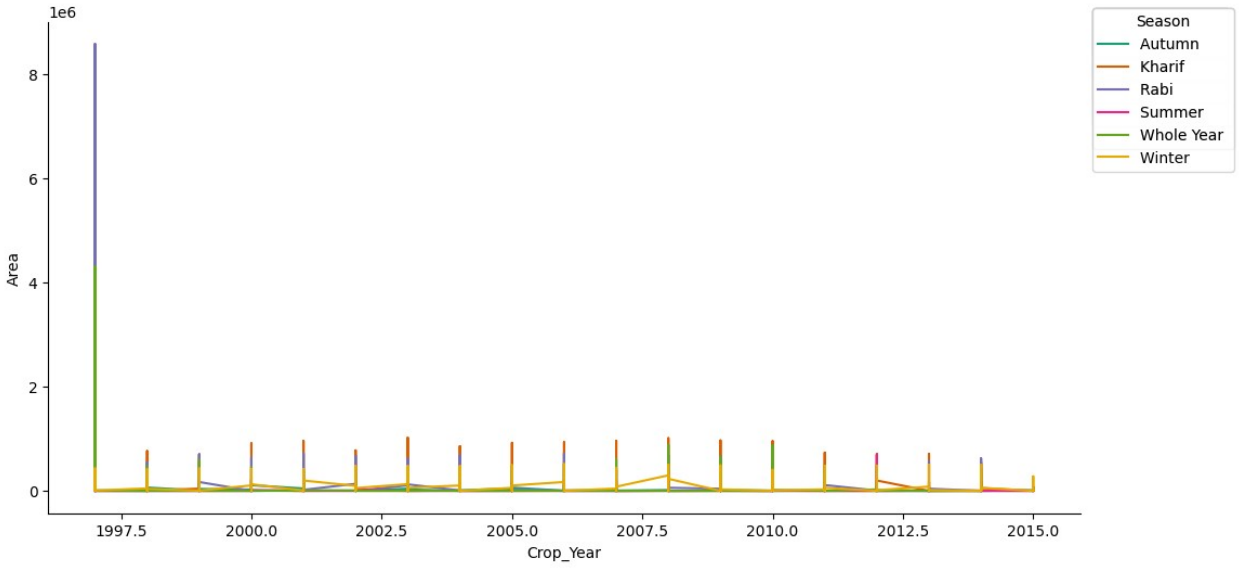
values grouped by Season and displayed on the horizontal bar chart

```
from matplotlib import pyplot as plt
import seaborn as sns
df.groupby('Season').size().plot(kind='barh',
color=sns.palettes.mpl_palette('Dark2'))
plt.gca().spines[['top', 'right',]].set_visible(False)
```



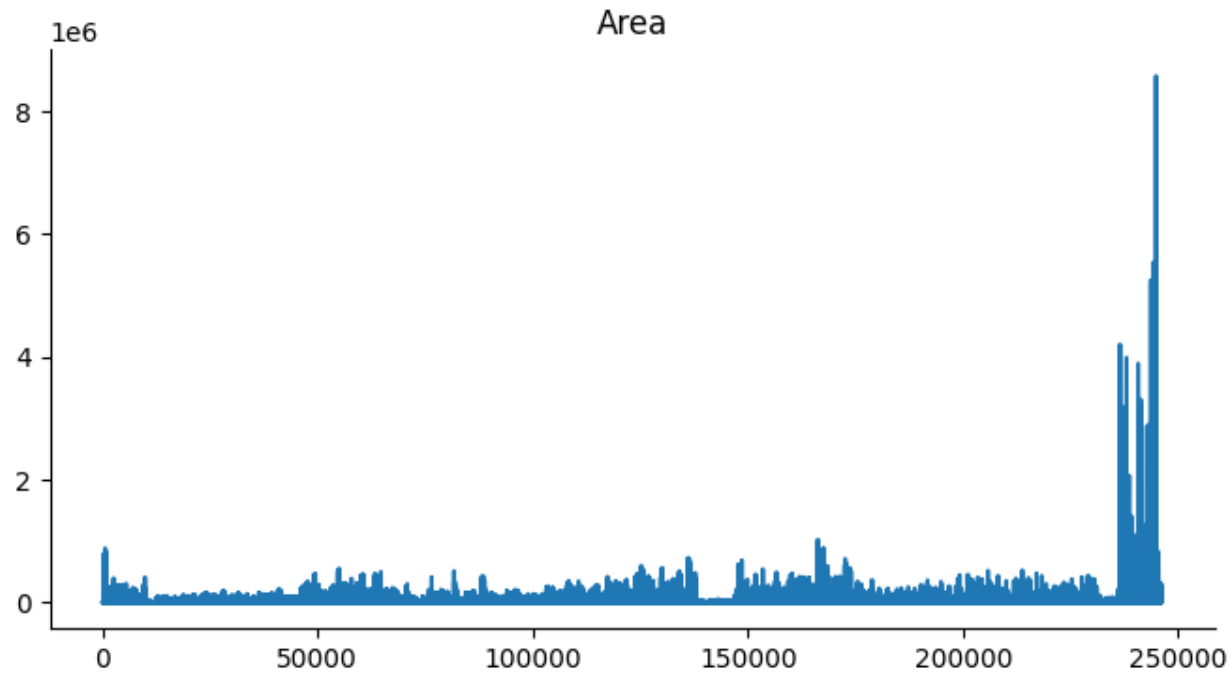
Plotting the series between Crop year and area

```
def _plot_series(series, series_name, series_index=0):
  palette = list(sns.palettes.mpl_palette('Dark2'))
  xs = series['Crop_Year']
  ys = series['Area']

  plt.plot(xs, ys, label=series_name, color=palette[series_index %
len(palette)])

fig, ax = plt.subplots(figsize=(10, 5.2), layout='constrained')
df_sorted = df.sort_values('Crop_Year', ascending=True)
for i, (series_name, series) in
enumerate(df_sorted.groupby('Season')):
  _plot_series(series, series_name, i)
  fig.legend(title='Season', bbox_to_anchor=(1, 1), loc='upper left')
sns.despine(fig=fig, ax=ax)
plt.xlabel('Crop_Year')
_ = plt.ylabel('Area')
```



Plot of area

```
df['Area'].plot(kind='line', figsize=(8, 4), title='Area')
plt.gca().spines[['top', 'right']].set_visible(False)
```




```
df.head(15)
```

{"type":"dataframe","variable_name":"df"}

Sum of production

```
print("Total Production:", df.Production.sum())
```

```
Total Production: 143348854606.9862
```

Total sum of area available

```
print("Total Area:", df.Area.sum())
```

```
Total Area: 2953786189.17
```

```
df.shape
```

```
(246091, 7)
```

Count of districts

```
df['District_Name'].value_counts()
```

```
District_Name
BIJAPUR      945
TUMKUR       936
BELGAUM      925
HASSAN       895
BELLARY      887
            ...
HYDERABAD      8
KHUNTI         6
RAMGARH        6
NAMSAI         1
MUMBAI         1
Name: count, Length: 646, dtype: int64
```

Value counts with respect to how many times it is mention in the table according to the seasons in which crop production is done

```
df['State_Name'].value_counts()
```

```
State_Name
Uttar Pradesh                  33306
Madhya Pradesh                 22943
```

```
Karnataka                        21122
Bihar                            18885
Assam                            14628
Odisha                           13575
Tamil Nadu                       13547
Maharashtra                      12628
Rajasthan                        12514
Chhattisgarh                     10709
Andhra Pradesh                    9628
West Bengal                       9613
Gujarat                           8436
Haryana                           5875
Telangana                         5649
Uttarakhand                       4896
Kerala                            4261
Nagaland                          3906
Punjab                            3173
Meghalaya                         2867
Arunachal Pradesh                 2546
Himachal Pradesh                  2494
Jammu and Kashmir                 1634
Tripura                           1412
Manipur                           1267
Jharkhand                         1266
Mizoram                            957
Puducherry                         876
Sikkim                             714
Dadra and Nagar Haveli             263
Goa                                208
Andaman and Nicobar Islands        203
Chandigarh                          90
Name: count, dtype: int64
```

#Count of values per season

```
df['Season'].value_counts()
```

```
Season
Kharif         95951
Rabi           66987
Whole Year     57305
Summer         14841
Winter          6058
Autumn          4949
Name: count, dtype: int64
```

#Finding the dummy values for the categorical variables

```
new_State = pd.get_dummies(df['State_Name'], dtype = 'int')
new_District = pd.get_dummies(df['District_Name'], dtype = 'int')
new_Season = pd.get_dummies(df['Season'], dtype = 'int')
new_Crop = pd.get_dummies(df['Crop'], dtype = 'int')
```

Converting the dummy values into the dataframe

```
State_ = pd.DataFrame(new_State)
District_= pd.DataFrame(new_District)
Season_ = pd.DataFrame(new_Season)
Crop_ = pd.DataFrame(new_Crop)
```

#Concatenating the new dataframes with the original one

```
new_df = pd.concat([State_, District_, Season_, Crop_, df], axis = 1)
```

#Displaying the new dataframe

```
new_df.head(10)
```

{"type":"dataframe","variable_name":"new_df"}

#Dropping the unnecessary attributes

```
new_df = new_df.drop({'State_Name', 'District_Name', 'Season',
'Crop'}, axis = 1)

new_df.head(10)
```

{"type":"dataframe","variable_name":"new_df"}

#Selecting the predictor and the target variable

```
X = new_df.drop('Production', axis = 1)
y =new_df[['Production']]
```

#Printing the shape of predictor and target variable

```
print(X.shape)
print(y.shape)
```

```
(246091, 811)
(246091, 1)
```

#Scaling the predictor and target variable

```
Scaler = MinMaxScaler()
X = Scaler.fit_transform(X)
y = Scaler.fit_transform(y)
```

#Splitting the dataset into training and testing set

```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size = 0.2)
```

#Printing the training and testing set

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(196872, 811)
(49219, 811)
(196872, 1)
(49219, 1)
```

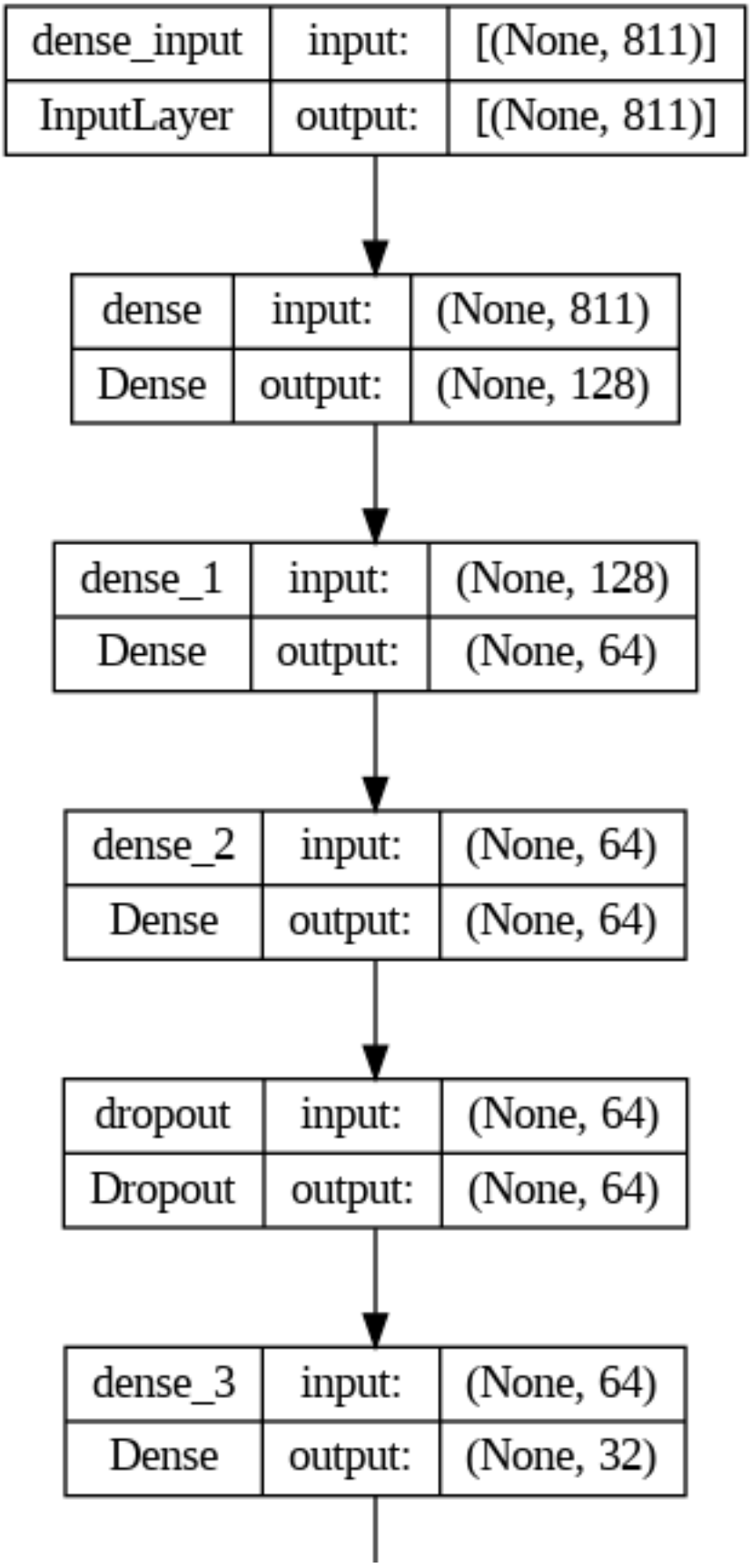
#Developing the sequential model

```
model = tf.keras.models.Sequential()
model.add(tf.keras.layers.Dense(units = 128, activation = 'relu',
input_shape = (811,)))
model.add(tf.keras.layers.Dense(units = 64, activation = 'relu'))
model.add(tf.keras.layers.Dense(units = 64, activation = 'relu'))
model.add(tf.keras.layers.Dropout(0.5))
model.add(tf.keras.layers.Dense(units = 32, activation = 'relu'))
model.add(tf.keras.layers.Dense(units = 32, activation = 'relu'))
model.add(tf.keras.layers.Dropout(0.5))
model.add(tf.keras.layers.Dense(units = 16, activation = 'relu'))
model.add(tf.keras.layers.Dense(units = 16, activation = 'relu'))
model.add(tf.keras.layers.Dropout(0.5))
model.add(tf.keras.layers.Dense(units = 8, activation = 'relu'))
model.add(tf.keras.layers.Dropout(0.5))
model.add(tf.keras.layers.Dense(units = 4, activation = 'relu'))
model.add(tf.keras.layers.Dense(units = 1, activation  = 'linear'))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 128)               103936

 dense_1 (Dense)             (None, 64)                8256

 dense_2 (Dense)             (None, 64)                4160
```

```
 dropout (Dropout)           (None, 64)                0

 dense_3 (Dense)             (None, 32)                2080

 dense_4 (Dense)             (None, 32)                1056

 dropout_1 (Dropout)         (None, 32)                0

 dense_5 (Dense)             (None, 16)                528

 dense_6 (Dense)             (None, 16)                272

 dropout_2 (Dropout)         (None, 16)                0

 dense_7 (Dense)             (None, 8)                 136

 dropout_3 (Dropout)         (None, 8)                 0

 dense_8 (Dense)             (None, 4)                 36

 dense_9 (Dense)             (None, 1)                 5

=================================================================
Total params: 120465 (470.57 KB)
Trainable params: 120465 (470.57 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
keras.utils.plot_model(model, to_file='png', show_shapes=True)
```


dense_input | input: | [(None, 811)]
InputLayer | output: | [(None, 811)]
dense | input: | (None, 811)
Dense | output: | (None, 128)
dense_1 | input: | (None, 128)
Dense | output: | (None, 64)
dense_2 | input: | (None, 64)
Dense | output: | (None, 64)
dropout | input: | (None, 64)
Dropout | output: | (None, 64)
dense_3 | input: | (None, 64)
Dense | output: | (None, 32)

#Training the model with the help of callbacks so as to avoid overfitting

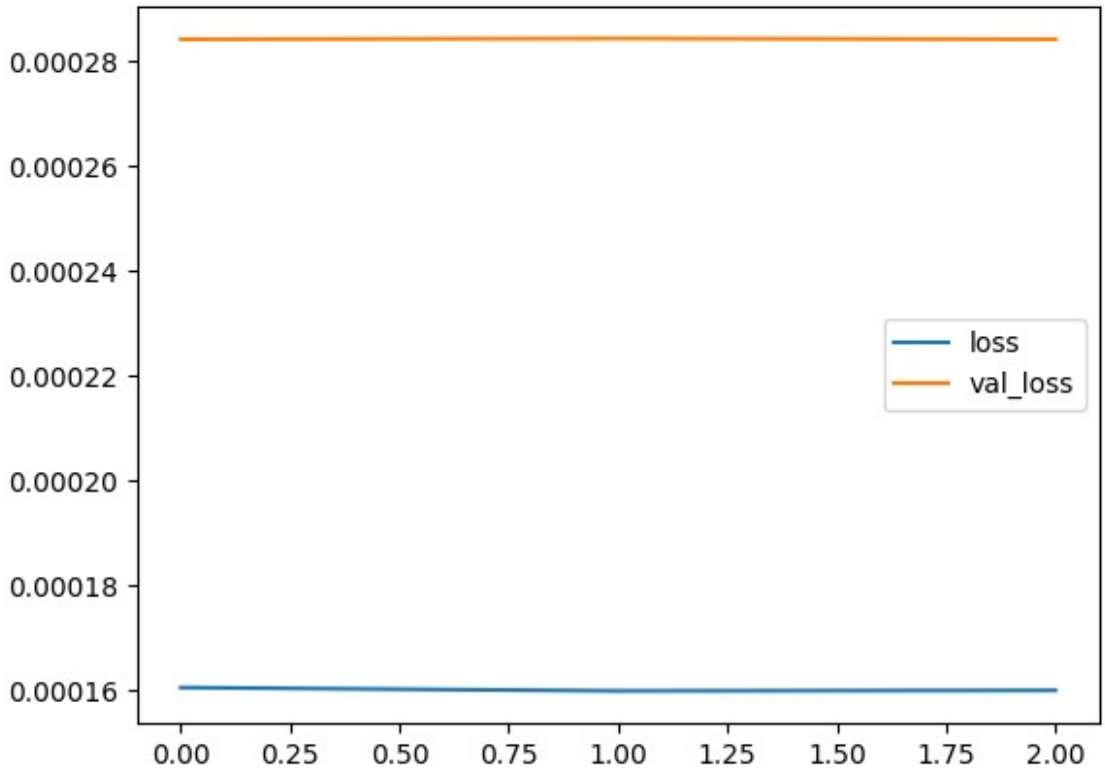
```
model.compile(optimizer = 'Adam', loss = 'mean_squared_error')
from keras.callbacks import EarlyStopping
es = EarlyStopping(patience = 2, monitor = 'val_loss')
model.fit(X_train, y_train, epochs = 25, batch_size = 10,
validation_data = (X_test, y_test), callbacks = [es])
```

```
Epoch 1/25
19688/19688 [==============================] - 114s 6ms/step - loss:
1.6057e-04 - val_loss: 2.8405e-04
Epoch 2/25
19688/19688 [==============================] - 107s 5ms/step - loss:
1.5994e-04 - val_loss: 2.8420e-04
Epoch 3/25
19688/19688 [==============================] - 109s 6ms/step - loss:
1.6003e-04 - val_loss: 2.8405e-04

<keras.src.callbacks.History at 0x7b8566507370>
```

#Plotting the history of the model

```
hist = model.history.history
h = pd.DataFrame(hist)
h.plot()
```

```
<Axes: >
```



#Model predicting the values

```
y_predict = model.predict(X_test)
y_predict
```

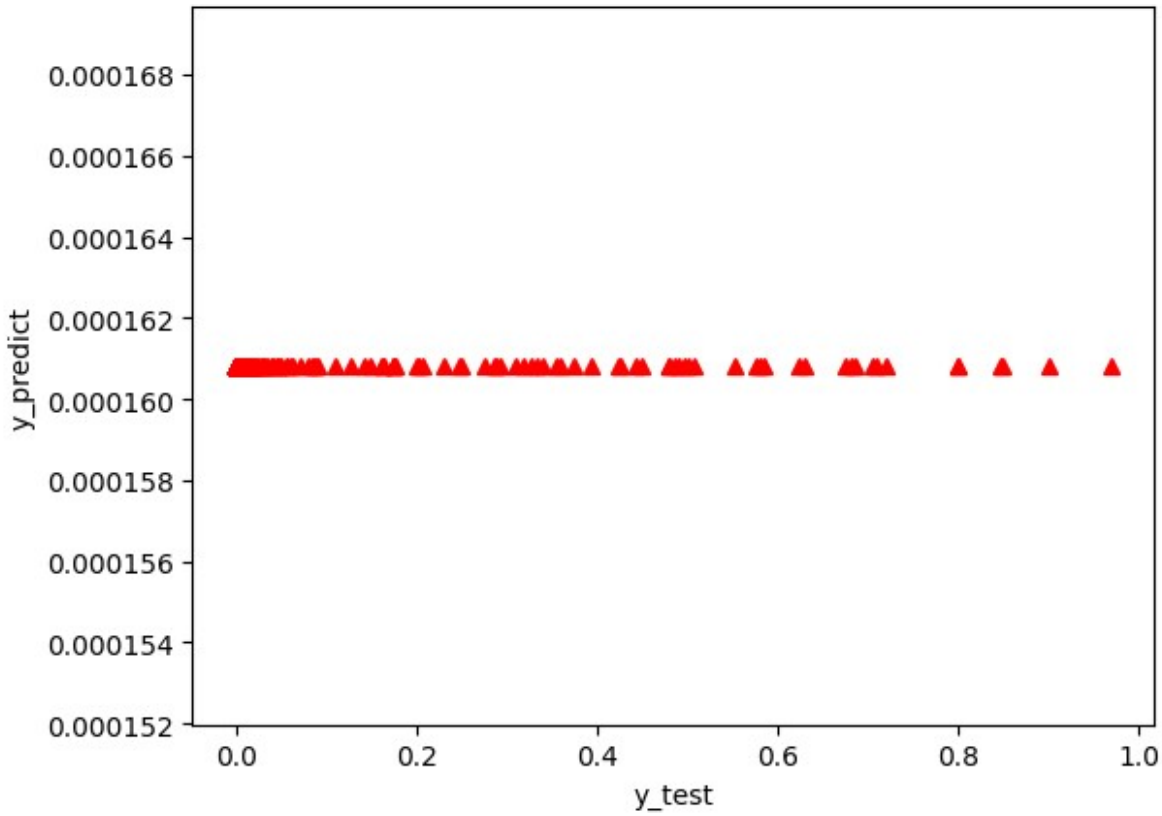
```
1539/1539 [==============================] - 3s 2ms/step
```

```
array([[0.00016082],
       [0.00016082],
       [0.00016082],
       ...,
       [0.00016082],
       [0.00016082],
       [0.00016082]], dtype=float32)
```

#Plot between predicted values and test values

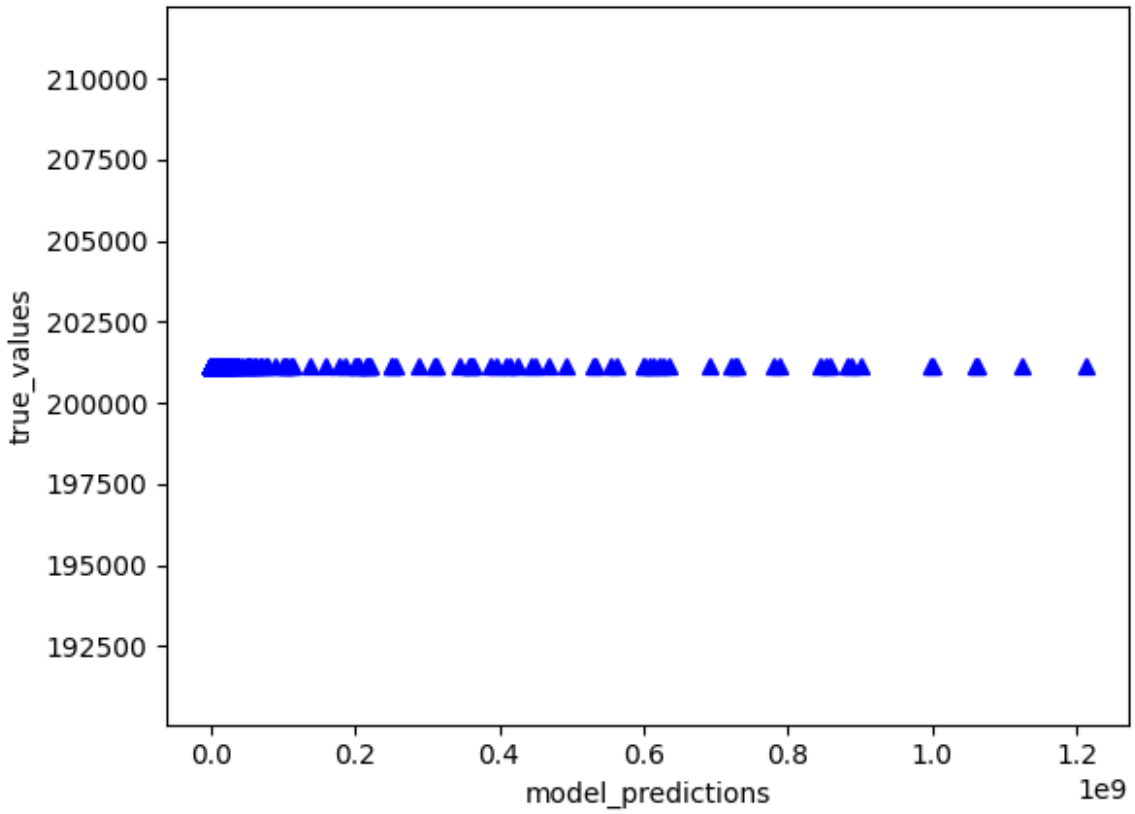
```
plt.plot(y_test,y_predict, '^', color = 'r')
plt.xlabel('y_test')
plt.ylabel('y_predict')
```

```
Text(0, 0.5, 'y_predict')
```



#Plot between model's predictions and the true values

```
y_predict_original = Scaler.inverse_transform(y_predict)
y_test_original = Scaler.inverse_transform(y_test)
plt.plot(y_test_original,y_predict_original,'^',color = 'b')
plt.xlabel('model_predictions')
plt.ylabel('true_values')

Text(0, 0.5, 'true_values')
```



#Calculation of value of n

```
k = X_test.shape
k
n = len(X_test)
n
```

```
49219
```

#Calculation of Root Mean Squared Value

```
from sklearn.metrics import
r2_score,mean_squared_error,mean_absolute_error
from math import sqrt
RMSE =
float(format(np.sqrt(mean_squared_error(y_test_original,y_predict_orig
inal)), '0.3f'))
print(RMSE)
```

```
21080981.274
```

#Calculation of Mean Squared Value

```
MSE = mean_squared_error(y_test_original,y_predict_original)
print(MSE)
```

```
444407771476213.7
```

#Calculation of Mean Absolute Value

```
MAE = mean_absolute_error(y_test_original,y_predict_original)
print(MAE)
```

```
900126.1386866091
```

#Calculation of R2 Score

```
r2 = r2_score(y_test_original,y_predict_original)
print(r2)
```

```
-0.0006611469950694726
```