n6qnh4u08ZQPhYc

April 11, 2025

Install Libraries

[13]:
```
# importing modules and packages
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.legend_handler import HandlerPathCollection
from sklearn import preprocessing
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error
from sklearn.impute import SimpleImputer
from sklearn.neighbors import LocalOutlierFactor
from sklearn.model_selection import LearningCurveDisplay, ShuffleSplit
```

Read data from csv file

[14]:
```
# importing data
df = pd.read_csv('Car_Details_original.csv')
df.drop('Make', inplace = True, axis=1)

print(df.head())
print(df.columns)
```

```
    Type Origin DriveTrain  EngineSize  Cylinders  Horsepower  MPG_City  \
0    SUV   Asia        All         3.5        6.0         265        17
1  Sedan   Asia      Front         2.0        4.0         200        24
2  Sedan   Asia      Front         2.4        4.0         200        22
3  Sedan   Asia      Front         3.2        6.0         270        20
4  Sedan   Asia      Front         3.5        6.0         225        18

   MPG_Highway  Weight  Wheelbase  Length   MSRP
0           23    4451        106     189  36945
1           31    2778        101     172  23820
2           29    3230        105     183  26990
3           28    3575        108     186  33195
4           24    3880        115     197  43755
Index(['Type', 'Origin', 'DriveTrain', 'EngineSize', 'Cylinders', 'Horsepower',
```

```
 'MPG_City', 'MPG_Highway', 'Weight', 'Wheelbase', 'Length', 'MSRP'],
dtype='object')
```

Create X & Y variables then clean data.

[15]:
```
# creating feature variables
X = df.drop('MSRP', axis= 1)
x_array = np.array(X)
X_num = df[['EngineSize', 'Cylinders', 'Horsepower', 'MPG_City', 'MPG_Highway',␣
↪'Weight', 'Wheelbase', 'Length']]
xn_array = np.array(X_num)
print(X)
print(x_array)
print(xn_array)

y = df['MSRP']
y_array = np.array(y)
y_array = y_array.reshape(-1, 1)
print(y)
print(y_array)

# Encoding categorical features of X
enc = preprocessing.OrdinalEncoder()
enc.fit(x_array)
x_array = enc.transform(x_array)
print(x_array)

#Standardising X & Y
x_scaler = preprocessing.StandardScaler()
x_scaler.fit(xn_array)
print(x_scaler)
print(x_scaler.mean_)
print(x_scaler.scale_)
xn_array = x_scaler.transform(xn_array)
print(xn_array)

y_scaler = preprocessing.StandardScaler()
y_scaler.fit(y_array)
print(y_scaler)
print(y_scaler.mean_)
print(y_scaler.scale_)
y_array = y_scaler.transform(y_array)
print(y_array)
```

```
    Type  Origin DriveTrain  EngineSize  Cylinders  Horsepower  MPG_City  \
0    SUV    Asia        All         3.5        6.0         265        17
1  Sedan    Asia      Front         2.0        4.0         200        24
2  Sedan    Asia      Front         2.4        4.0         200        22
```

```
3    Sedan    Asia      Front         3.2         6.0         270         20
4    Sedan    Asia      Front         3.5         6.0         225         18
..     …      …         …         …         …         …       …
423  Sedan  Europe      Front         2.4         5.0         197         21
424  Sedan  Europe      Front         2.3         5.0         242         20
425  Sedan  Europe      Front         2.9         6.0         268         19
426  Wagon  Europe      Front         1.9         4.0         170         22
427  Wagon  Europe        All         2.5         5.0         208         20

     MPG_Highway  Weight  Wheelbase  Length
0             23    4451        106     189
1             31    2778        101     172
2             29    3230        105     183
3             28    3575        108     186
4             24    3880        115     197
..           …     …         …     …
423           28    3450        105     186
424           26    3450        105     186
425           26    3653        110     190
426           29    2822        101     180
427           27    3823        109     186

[428 rows x 11 columns]
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       …
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```

Detecting Missing Values and Outliers. Plot current heatmap.

[16]:
```
# Handle Missing text values in X variables.
x_imp = SimpleImputer(strategy="most_frequent")
x_imp.fit(x_array)
x_array = x_imp.transform(x_array)
print(x_array)

# Handle NaN values in X and Y variables.
xn_imp = SimpleImputer(missing_values=np.nan, strategy='mean')
xn_imp.fit(xn_array)
xn_array = xn_imp.transform(xn_array)
print(xn_array)

y_imp = SimpleImputer(missing_values=np.nan, strategy='mean')
y_imp.fit(y_array)
y_array = y_imp.transform(y_array)
print(y_array)

# Detect Outliers
ground_truth = np.ones(len(xn_array), dtype=int)
clf = LocalOutlierFactor(n_neighbors=20, contamination=0.1)
y_pred = clf.fit_predict(xn_array)
n_errors = (y_pred != ground_truth).sum()
X_scores = clf.negative_outlier_factor_
```

```python
# Plot current heatmap
def update_legend_marker_size(handle, orig):
    "Customize size of the legend marker"
    handle.update_from(orig)
    handle.set_sizes([20])

plt.scatter(xn_array[:, 0], xn_array[:, 1], color="k", s=3.0, label="Data␣
↪points")
# plot circles with radius proportional to the outlier scores
radius = (X_scores.max() - X_scores) / (X_scores.max() - X_scores.min())
scatter = plt.scatter(
    xn_array[:, 0],
    xn_array[:, 1],
    s=1000 * radius,
    edgecolors="r",
    facecolors="none",
    label="Outlier scores",
)
plt.axis("tight")
plt.xlim((-5, 10))
plt.ylim((-5, 10))
plt.xlabel("prediction errors: %d" % (n_errors))
plt.legend(
    handler_map={scatter:␣
↪HandlerPathCollection(update_func=update_legend_marker_size)}
)
plt.title("Local Outlier Factor (LOF)")
plt.show()
```

```
[[  1.    0.    0. … 300.   13.   37.]
 [  2.    0.    1. …  50.    8.   20.]
 [  2.    0.    1. … 105.   12.   31.]
 …
 [  2.    1.    1. … 201.   17.   38.]
 [  5.    1.    1. …  55.    8.   28.]
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 …
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  -0.44362717]]
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[-9.00605524e-01]
```
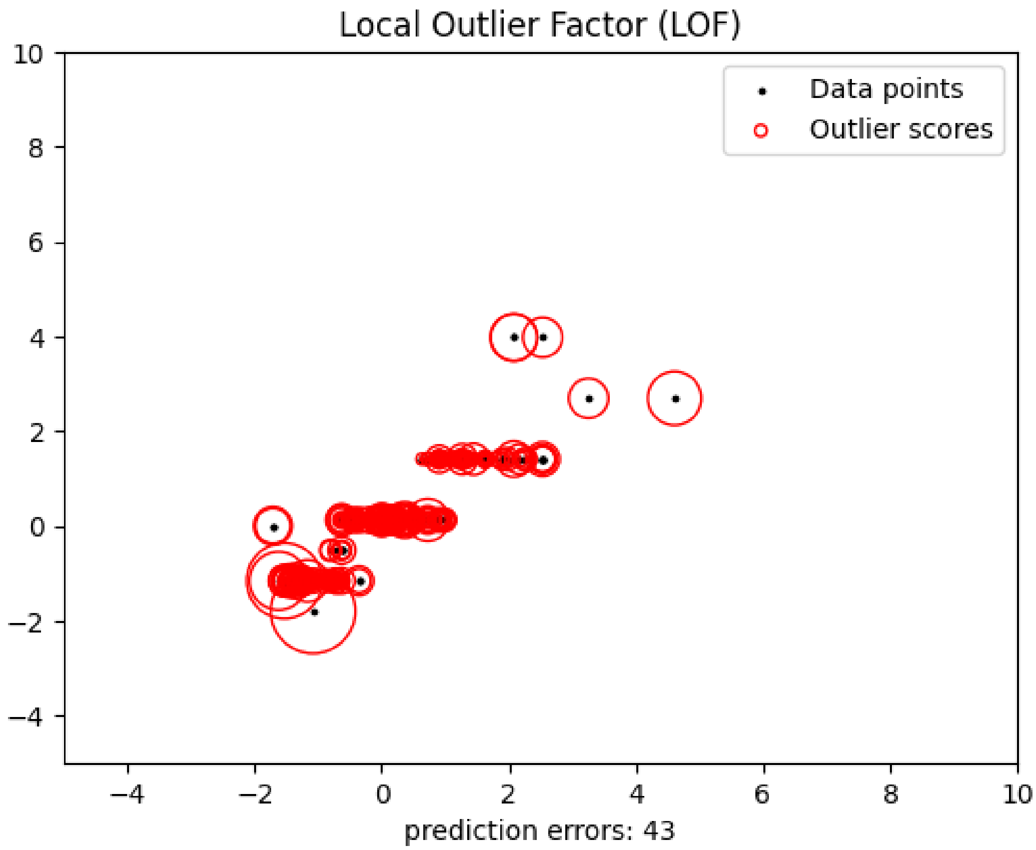

```
[-1.13425998e+00]
[-1.09304200e+00]
[-1.10695307e+00]
[-6.80862138e-01]
[-5.15217358e-01]
[-6.76997952e-01]
[-5.56950568e-01]
[-3.20204763e-01]
[-3.53179152e-01]
[-3.22780887e-01]
[-9.55667408e-02]
[-4.78121171e-01]
[-2.04794403e-01]
[-5.25779467e-01]
[-3.93881912e-01]
[-1.02915412e+00]
[-8.38778546e-01]
[-3.52406314e-01]
[-8.28474049e-01]
[ 1.41179065e-01]
[-7.24398635e-01]
[-6.67208680e-01]
[-6.03836027e-01]
[-6.03836027e-01]
[-4.63179651e-01]
[-4.92547466e-01]
[-4.54420829e-01]
[ 2.08740688e-02]
[ 3.32842698e-01]
[ 1.66031945e+00]
[ 2.17554427e+00]
[-7.09457116e-01]
[-4.02898347e-01]
[ 3.84365180e-01]
[ 4.36660500e-01]
[-3.93624300e-01]
[-5.30606931e-02]
[ 1.06659002e-01]
[ 2.46542541e-01]
[ 2.55301363e-01]
[ 2.63287347e-01]
[ 4.01367599e-01]
[ 5.04412564e-01]
[ 6.40689529e-01]
[-3.42101818e-01]
[ 1.22115746e-01]]
```



Create a Linear Regression model

[17]:
```
# creating train and test sets
X_train, X_test, y_train, y_test = train_test_split(xn_array, y_array,␣
 ↪test_size=0.3, random_state=101)

# creating a regression model
model = LinearRegression()

# fitting the model
model.fit(X_train,y_train)

# making predictions
predictions = model.predict(X_test)
print(predictions)

# model evaluation
print('Test mean_squared_error : ', mean_squared_error(y_test, predictions))
print( 'Test mean_absolute_error : ', mean_absolute_error(y_test, predictions))
```

```
[[-5.84400016e-01]
```

```
[ 1.32254861e-01]
[ 3.27772812e-01]
[-6.05447767e-01]
[-5.30924351e-01]
[ 5.57157163e-03]
[ 2.20833707e-01]
[-4.98926267e-01]
[-2.69332324e-01]
[-8.15650135e-01]
[-6.17320953e-01]
[-8.72374775e-01]
[-8.97804204e-01]
[-1.14428234e+00]
[ 9.62466467e-01]
[ 1.40432254e+00]
[-1.13387324e+00]
[ 5.60176917e-01]
[ 3.30903599e-02]
[-2.86362311e-01]
[-3.12094012e-01]
[-2.00835818e-01]
[-3.09483596e-01]
[ 1.29332117e+00]
[ 5.59249270e-01]
[-1.55699473e-01]
[ 1.69603935e+00]
[ 4.10522313e-02]
[-9.82505428e-01]
[-5.44439518e-01]
[ 1.92166687e-01]
[ 1.56061208e+00]
[ 8.86217028e-02]
[ 6.93148539e-01]
[ 7.85415977e-01]
[-1.13335131e+00]
[-8.58099306e-01]
[-7.97406408e-01]
[-3.18175553e-01]
[ 4.33215370e-01]
[ 2.81923712e-01]
[-3.67050990e-01]
[ 9.13548203e-01]
[-9.69742968e-01]
[-8.24356639e-01]
[ 1.01793539e+00]
[ 5.36588239e-02]
[ 2.21609503e-01]
[-2.74060359e-01]
```

```
[-3.57446165e-01]
[ 1.07985887e-01]
[-2.59053403e-02]
[ 4.89562256e-01]
[-1.40088302e-01]
[ 9.69804743e-01]
[-1.30009677e-01]
[ 2.50129809e-01]
[-8.68567761e-02]
[-1.15943391e+00]
[ 4.30799753e-01]
[-8.15650135e-01]
[ 1.66302008e-01]
[ 2.25422151e-03]
[ 1.17279632e+00]
[ 2.03082822e-01]
[-7.32194136e-01]
[-1.69615207e-01]
[-9.84639905e-01]
[ 1.14781384e+00]
[-4.23731733e-01]
[-7.75996348e-01]
[-2.37564667e-01]
[-4.70231143e-01]
[-7.49726080e-01]
[ 2.61058181e-01]
[-8.89869795e-02]
[ 2.38970713e-01]
[-7.97406408e-01]
[-2.31582664e-02]
[-1.08570366e+00]
[-2.96408062e-01]
[ 1.03526418e+00]
[-9.81238532e-01]
[ 4.12422435e+00]
[-7.93715674e-01]
[-4.89255196e-01]
[ 1.17517253e+00]
[ 5.73532440e-01]
[-4.63089421e-01]
[ 1.31977847e+00]
[ 3.15123297e-01]
[ 1.50202445e-01]
[ 1.73681068e-01]
[ 2.40342911e-02]
[ 1.57870500e+00]
[ 2.54767614e-02]
[ 1.97043878e-01]
```

```
 [ 1.20794462e+00]
 [-9.98205123e-01]
 [ 3.02108274e-01]
 [ 4.39202613e-01]
 [ 8.61620751e-01]
 [-7.78786400e-01]
 [-5.58699717e-01]
 [-6.99867311e-01]
 [-6.15101377e-01]
 [ 8.18825178e-01]
 [-7.85762239e-01]
 [-4.52841904e-01]
 [-2.85261961e-01]
 [-9.26211908e-01]
 [-8.34749799e-01]
 [ 2.96909440e-01]
 [ 1.58550861e-01]
 [-1.16829904e+00]
 [ 1.81711086e-01]
 [-1.15422845e-01]
 [ 8.18825178e-01]
 [ 4.98486926e-03]
 [-6.54949509e-01]
 [ 8.31910779e-01]
 [-7.58058673e-01]
 [-6.95045002e-01]
 [ 1.34654272e+00]
 [-1.28547730e-01]
 [ 3.22264892e+00]
 [ 7.11765018e-03]
 [ 2.59840532e-01]
 [-1.60923069e-01]]
Test mean_squared_error :  0.2190712772454837
Test mean_absolute_error :  0.3404897404251003
```

Plot learning curve for model.

[18]:
```python
# Create the regression model
regressor = RandomForestRegressor(n_estimators=100, random_state=42)
fig, ax = plt.subplots(nrows=1, ncols=2, figsize=(10, 6), sharey=True)

common_params = {
    "X": xn_array,
    "y": y_array,
    "train_sizes": np.linspace(0.1, 1.0, 5),
    "cv": ShuffleSplit(n_splits=50, test_size=0.2, random_state=0),
    "score_type": "both",
    "n_jobs": 4,
```

```
    "line_kw": {"marker": "o"},
    "std_display_style": "fill_between",
    "score_name": "R2 Score",
}

# Create a list of estimators to compare
estimators = [model, regressor]

for ax_idx, estimator in enumerate(estimators):
    LearningCurveDisplay.from_estimator(estimator, **common_params,␣
 ↪ax=ax[ax_idx])
    handles, label = ax[ax_idx].get_legend_handles_labels()
    ax[ax_idx].legend(handles[:2], ["Training Score", "Test Score"])
    ax[ax_idx].set_title(f"Learning Curve for {estimator.__class__.__name__}")
```