Final Project Data Model(CPE232)

Project : Mercedes Benz Price Prediction

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Import library & Dataset

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
```

```
from google.colab import drive
drive.mount('/content/drive')
mercedes = pd.read_csv('/content/drive/MyDrive/Final Project _ Data Model/mercedes-price.csv')
```

```
Mounted at /content/drive
```

Preview Data

```
mercedes
```

	model	year	price	transmission	mileage	fuelType	tax	mpg	engineSize
0	SLK	2005	5200	Automatic	63000	Petrol	325	32.1	1.8
1	S Class	2017	34948	Automatic	27000	Hybrid	20	61.4	2.1
2	SL CLASS	2016	49948	Automatic	6200	Petrol	555	28.0	5.5
3	G Class	2016	61948	Automatic	16000	Petrol	325	30.4	4.0
4	G Class	2016	73948	Automatic	4000	Petrol	325	30.1	4.0
...	...	...	...	...	...	...	...	...	...
13114	C Class	2020	35999	Automatic	500	Diesel	145	55.4	2.0
13115	B Class	2020	24699	Automatic	2500	Diesel	145	55.4	2.0
13116	GLC Class	2019	30999	Automatic	11612	Diesel	145	41.5	2.1
13117	CLS Class	2019	37990	Automatic	2426	Diesel	145	45.6	2.0
13118	S Class	2019	54999	Automatic	2075	Diesel	145	52.3	2.9

13119 rows × 9 columns

Cleaning Data

Check Data type info

```
mercedes.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 13119 entries, 0 to 13118
Data columns (total 9 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   model         13119 non-null  object 
 1   year          13119 non-null  int64  
 2   price         13119 non-null  int64  
 3   transmission  13119 non-null  object 
 4   mileage       13119 non-null  int64  
 5   fuelType      13119 non-null  object 
 6   tax           13119 non-null  int64  
 7   mpg           13119 non-null  float64
 8   engineSize    13119 non-null  float64
dtypes: float64(2), int64(4), object(3)
memory usage: 922.6+ KB
```

Check Null value

```
mercedes.isnull().any()
```

```
model           False
year            False
price           False
transmission    False
mileage         False
fuelType        False
tax             False
mpg             False
engineSize      False
dtype: bool
```

Shape function

```
mercedes.shape
```

```
(13119, 9)
```

Preprocess data

```
mercedes.head()
```

	model	year	price	transmission	mileage	fuelType	tax	mpg	engineSize
0	SLK	2005	5200	Automatic	63000	Petrol	325	32.1	1.8
1	S Class	2017	34948	Automatic	27000	Hybrid	20	61.4	2.1
2	SL CLASS	2016	49948	Automatic	6200	Petrol	555	28.0	5.5
3	G Class	2016	61948	Automatic	16000	Petrol	325	30.4	4.0
4	G Class	2016	73948	Automatic	4000	Petrol	325	30.1	4.0

Checking frequency of 'transmission'

```
pd.crosstab(mercedes['transmission'], columns='Count')
```

col_0	Count
transmission	
Automatic	4825
Manual	1444
Other	2
Semi-Auto	6848

- Note that, from column of transmission which contain Automatic, Manual, Semi-Auto and Other would see a 'Other' column were have only 2 data which could cause outlier.

Cleansing data by deleting transmission type 'Other'

```
cleansing1 = mercedes[mercedes['transmission'] != 'Other'].dropna()
cleansing1
```

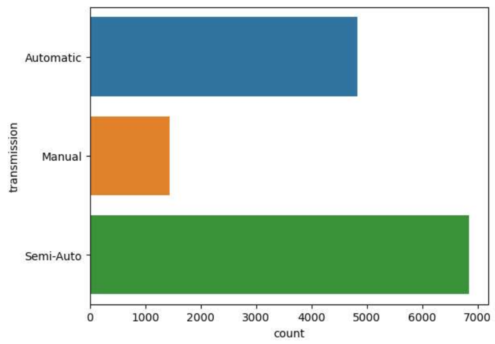
	model	year	price	transmission	mileage	fuelType	tax	mpg	engineSize
0	SLK	2005	5200	Automatic	63000	Petrol	325	32.1	1.8
1	S Class	2017	34948	Automatic	27000	Hybrid	20	61.4	2.1
2	SL CLASS	2016	49948	Automatic	6200	Petrol	555	28.0	5.5
3	G Class	2016	61948	Automatic	16000	Petrol	325	30.4	4.0
4	G Class	2016	73948	Automatic	4000	Petrol	325	30.1	4.0
...	...	...	...	...	...	...	...	...	...
13114	C Class	2020	35999	Automatic	500	Diesel	145	55.4	2.0
13115	B Class	2020	24699	Automatic	2500	Diesel	145	55.4	2.0
13116	GLC Class	2019	30999	Automatic	11612	Diesel	145	41.5	2.1
13117	CLS Class	2019	37990	Automatic	2426	Diesel	145	45.6	2.0
13118	S Class	2019	54999	Automatic	2075	Diesel	145	52.3	2.9

13117 rows × 9 columns

Showing 'transmission' data which had cleansed

```
sns.countplot(data=cleansing1, y='transmission')
```

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



Checking frequency of 'fuelType'

```
pd.crosstab(mercedes['fuelType'], columns='Count')
```

col_0	Count
fuelType	
Diesel	9187
Hybrid	173
Other	7
Petrol	3752

- Note that, from column of fuelType which contain Automatic, Manual, Semi-Auto and Other would see a 'Other' column were have only 2 data which could cause outlier.

Cleansing data by deleting fuelType type 'Other'

```
cleansing2 = cleansing1[cleansing1['fuelType'] != 'Other'].dropna()
cleansing2
```

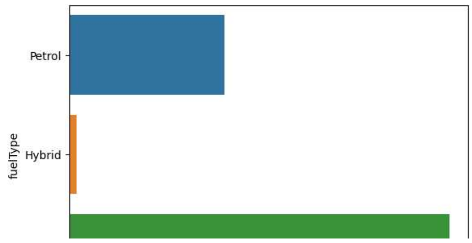
	model	year	price	transmission	mileage	fuelType	tax	mpg	engineSize
0	SLK	2005	5200	Automatic	63000	Petrol	325	32.1	1.8
1	S Class	2017	34948	Automatic	27000	Hybrid	20	61.4	2.1
2	SL CLASS	2016	49948	Automatic	6200	Petrol	555	28.0	5.5
3	G Class	2016	61948	Automatic	16000	Petrol	325	30.4	4.0
4	G Class	2016	73948	Automatic	4000	Petrol	325	30.1	4.0
...	...	...	...	...	...	...	...	...	...
13114	C Class	2020	35999	Automatic	500	Diesel	145	55.4	2.0
13115	B Class	2020	24699	Automatic	2500	Diesel	145	55.4	2.0
13116	GLC Class	2019	30999	Automatic	11612	Diesel	145	41.5	2.1
13117	CLS Class	2019	37990	Automatic	2426	Diesel	145	45.6	2.0
13118	S Class	2019	54999	Automatic	2075	Diesel	145	52.3	2.9

13111 rows × 9 columns

Showing 'transmission' data which had cleansed

```
sns.countplot(data=cleansing2, y='fuelType')
```

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



Describing Data

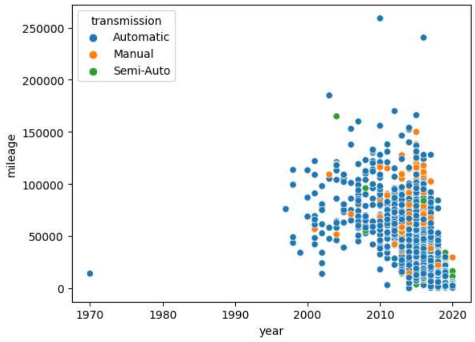
```
mercedes2 = cleansing2.loc[:,'price':'engineSize']
mercedes2.describe()
```

	price	mileage	tax	mpg	engineSize
count	13111.000000	13111.000000	13111.000000	13111.000000	13111.000000
mean	24700.935016	21935.920067	130.020212	55.117443	2.071642
std	11843.607522	21169.443845	65.230548	15.094034	0.572256
min	650.000000	1.000000	0.000000	1.100000	0.000000
25%	17450.000000	6090.000000	125.000000	45.600000	1.800000
50%	22480.000000	15181.000000	145.000000	56.500000	2.000000
75%	28980.000000	31733.000000	145.000000	64.200000	2.100000
max	159999.000000	259000.000000	580.000000	217.300000	6.200000

Showing 'fuelType' data which had cleansed

```
sns.scatterplot(data=cleansing2, x="year", y = "mileage",hue="transmission")
```

```
<Axes: xlabel='year', ylabel='mileage'>
```



- Find Outlier, so we should cleansing again by delete 1970 data.

```
mercedes2 = cleansing2[cleansing2['year'] != 1970].dropna()
mercedes2
```

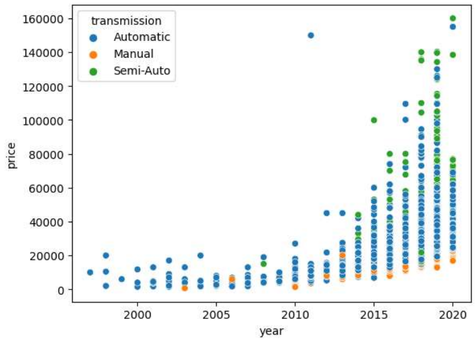
	model	year	price	transmission	mileage	fuelType	tax	mpg	engineSize
0	SLK	2005	5200	Automatic	63000	Petrol	325	32.1	1.8
1	S Class	2017	34948	Automatic	27000	Hybrid	20	61.4	2.1
2	SL CLASS	2016	49948	Automatic	6200	Petrol	555	28.0	5.5
3	G Class	2016	61948	Automatic	16000	Petrol	325	30.4	4.0
4	G Class	2016	73948	Automatic	4000	Petrol	325	30.1	4.0
...	...	...	...	...	...	...	...	...	...
13114	C Class	2020	35999	Automatic	500	Diesel	145	55.4	2.0
13115	B Class	2020	24699	Automatic	2500	Diesel	145	55.4	2.0
13116	GLC Class	2019	30999	Automatic	11612	Diesel	145	41.5	2.1
13117	CLS Class	2019	37990	Automatic	2426	Diesel	145	45.6	2.0
13118	S Class	2019	54999	Automatic	2075	Diesel	145	52.3	2.9

13110 rows × 9 columns

Number of sold car model each year

```
sns.scatterplot(data=mercedes2, x="year", y = "price",hue="transmission")
```

```
<Axes: xlabel='year', ylabel='price'>
```



Describing data

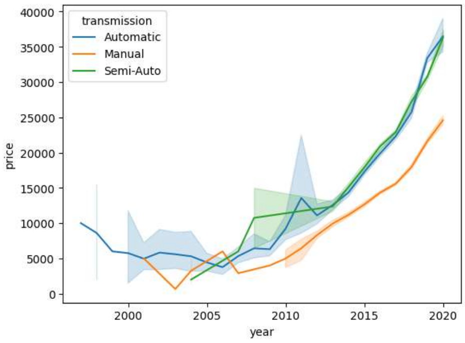
```
mercedes2.describe()
```

	year	price	mileage	tax	mpg	engineSize
count	13110.000000	13110.000000	13110.000000	13110.000000	13110.000000	13110.000000
mean	2017.300381	24700.912281	21936.525400	130.006865	55.118658	2.071800
std	2.186392	11844.058963	21170.137793	65.215130	15.093970	0.571991
min	1997.000000	650.000000	1.000000	0.000000	1.100000	0.000000
25%	2016.000000	17450.000000	6087.000000	125.000000	45.600000	1.800000
50%	2018.000000	22480.000000	15181.500000	145.000000	56.500000	2.000000

Show a price each transmission and each year

```
sns.lineplot(data=mercedes2, x="year", y="price", hue="transmission")
```

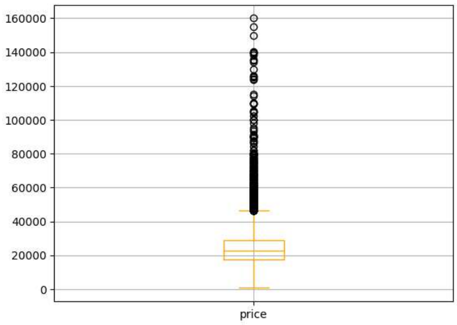
```
<Axes: xlabel='year', ylabel='price'>
```



Boxplot of price

```
mercedes2.boxplot(column='price', color='orange')
```

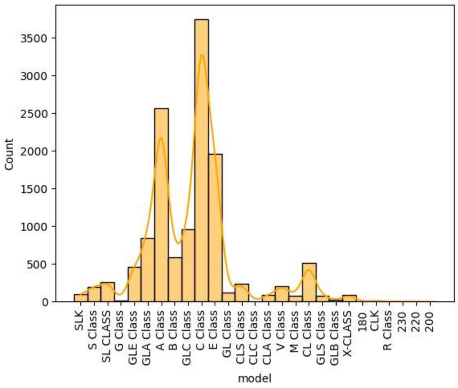
```
<Axes: >
```



Histrogram of mercedes model

```
ax = sns.histplot(data=mercedes2, x="model", kde=True, color='orange')
ax.set_xticklabels(ax.get_xticklabels(), rotation=90)
plt.show()
```

```
<ipython-input-22-c7d06b28821e>:2: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(ax.get_xticklabels(), rotation=90)
```



Histrogram of price

```
sns.histplot(data=mercedes2, x="price", kde=True, color='orange')
```

```
<Axes: xlabel='price', ylabel='Count'>
```

Relation graph between model and price.

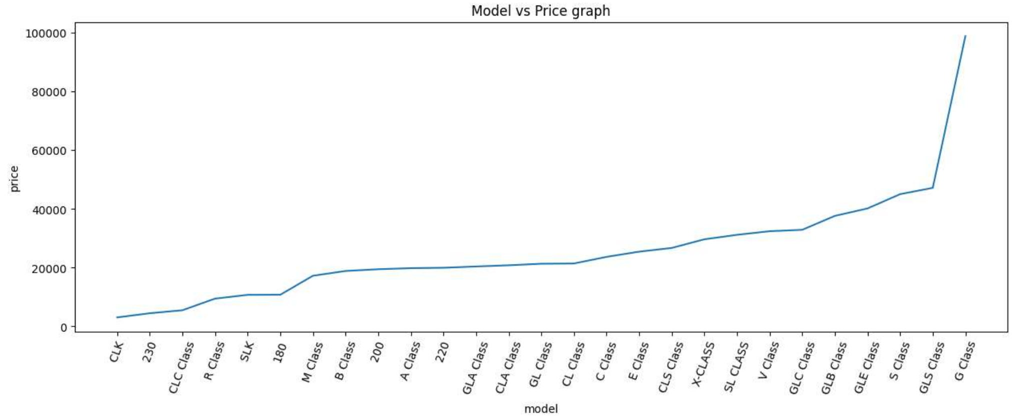
```
model_mileage = mercedes2.groupby('model')['price'].mean().sort_values()
plt.figure(figsize=(15,5))
pal = sns.color_palette("Oranges", len(model_mileage))
sns.lineplot(x=model_mileage.index , y=model_mileage , palette=pal)

plt.xticks(rotation=70)

plt.title('Model vs Price graph')

plt.savefig("model_mileage.png")
```

```
<ipython-input-24-e940c74c0a7b>:4: UserWarning: Ignoring `palette` because no `hue` variable has been assigned.
  sns.lineplot(x=model_mileage.index , y=model_mileage , palette=pal)
```



Correlation

```
mercedes2.corr()
```

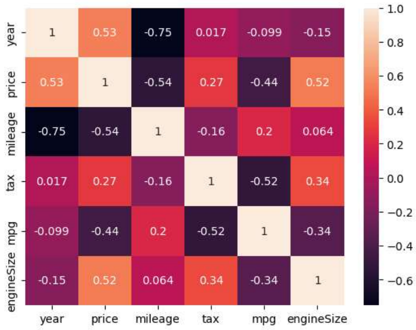
```
<ipython-input-28-07e1643968ce>:1: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only valid columns or specify the value of numeric_onl
  mercedes2.corr()
```

	year	price	mileage	tax	mpg	engineSize
year	1.000000	0.529856	-0.751821	0.016777	-0.099067	-0.150917
price	0.529856	1.000000	-0.537120	0.268688	-0.442304	0.516591
mileage	-0.751821	-0.537120	1.000000	-0.159173	0.202571	0.063691
tax	0.016777	0.268688	-0.159173	1.000000	-0.515186	0.339955
mpg	-0.099067	-0.442304	0.202571	-0.515186	1.000000	-0.343336
engineSize	-0.150917	0.516591	0.063691	0.339955	-0.343336	1.000000

Correlation Heatmap

```
#sns.set(font_scale=0.8)
sns.heatmap(mercedes2.corr(), annot=True)
plt.show()
```

```
<ipython-input-30-01cefc933d82>:2: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only valid columns or specify the value of numeric_onl
  sns.heatmap(mercedes2.corr(), annot=True)
```



Modeling

```
from statsmodels.formula.api import ols

model = ols('price ~ year + model + mileage',mercedes2, missing='drop').fit()
model.summary()
```

OLS Regression Results

Dep. Variable:	price	**R-squared:**	0.584
Model:	OLS	**Adj. R-squared:**	0.584
Method:	Least Squares	**F-statistic:**	657.1
Date:	Thu, 18 May 2023	**Prob (F-statistic):**	0.00
Time:	05:06:05	**Log-Likelihood:**	-1.3581e+05
No. Observations:	13110	**AIC:**	2.717e+05
Df Residuals:	13081	**BIC:**	2.719e+05
Df Model:	28		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Intercept	-3.526e+06	9.99e+04	-35.280	0.000	-3.72e+06	-3.33e+06
model[T. B Class]	-1934.0683	349.020	-5.541	0.000	-2618.199	-1249.938
model[T. C Class]	4045.4522	196.084	20.631	0.000	3661.099	4429.805
model[T. CL Class]	2958.9588	370.586	7.985	0.000	2232.555	3685.362
model[T. CLA Class]	3071.7647	838.476	3.664	0.000	1428.231	4715.299
model[T. CLC Class]	4374.3458	4423.257	0.989	0.323	-4295.880	1.3e+04
model[T. CLK]	2.173e+04	2929.760	7.418	0.000	1.6e+04	2.75e+04
model[T. CLS Class]	9508.2015	519.746	18.294	0.000	8489.424	1.05e+04
model[T. E Class]	6387.2715	229.843	27.790	0.000	5936.746	6837.797
model[T. G Class]	7.961e+04	1979.464	40.219	0.000	7.57e+04	8.35e+04
model[T. GL Class]	6627.7082	713.375	9.291	0.000	5229.390	8026.026
model[T. GLA Class]	1407.0666	303.226	4.640	0.000	812.699	2001.434
model[T. GLB Class]	1.013e+04	1762.041	5.748	0.000	6673.581	1.36e+04
model[T. GLC Class]	1.12e+04	290.095	38.598	0.000	1.06e+04	1.18e+04
model[T. GLE Class]	1.922e+04	387.228	49.642	0.000	1.85e+04	2e+04

```
res = model.predict(mercedes2)
res
```

```
0        -1319.685505
1        44708.037036
2        30963.314988
3        97786.336973
4        99702.669125
             ...
13114    31731.223619
13115    25432.314421
13116    35349.176260
13117    35127.207280
13118    52206.807356
Length: 13110, dtype: float64
```

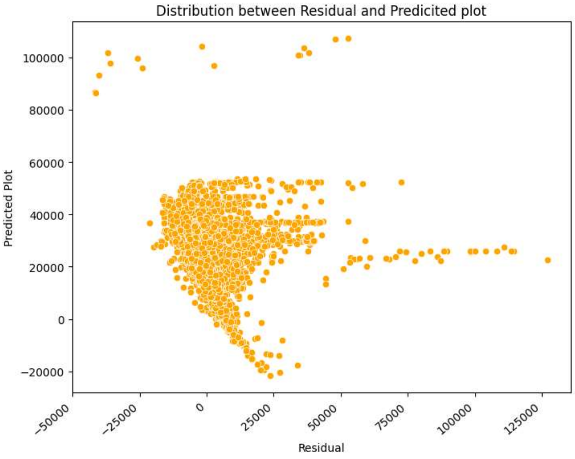
mileage	-0.1597	0.005	-32.697	0.000	-0.169	-0.150

Distribution between Residual and Predicted plot

```
fig, ax = plt.subplots(figsize=(8, 6))
ax.set(title="Distribution between Residual and Predicited plot", xlabel="Residual", ylabel="Predicted Plot")
sns.scatterplot(x=model.resid, y=res, color='orange')
ax.set_xticklabels(ax.get_xticklabels(), rotation=40, ha="right")

plt.show()
```

```
<ipython-input-44-ca3acec60a0e>:4: UserWarning: FixedFormatter should only be used together with FixedLocator
  ax.set_xticklabels(ax.get_xticklabels(), rotation=40, ha="right")
```



Accuracy

```
mercedes_num = mercedes2.select_dtypes('number')

mercedes_object = mercedes2.select_dtypes('object')

mercedes_object1 = pd.get_dummies(mercedes_object, drop_first=True, columns=(['transmission','fuelType','model']))
#mercedes_object1 = pd.get_dummies(mercedes_object, drop_first=True)

mercedes_prep = pd.concat([mercedes_num,mercedes_object1], axis=1)
mercedes_prep
```

	year	price	mileage	tax	mpg	engineSize	transmission_Manual	transmission_Semi-Auto	fuelType_Hybrid	fuelType_Petrol	...	model_ R Class	model_ S Class	model_ SL CLASS	model_ SLK	model_ V Class	model_ X-CLASS	model_180	model_200	model_220	model_230
0	2005	5200	63000	325	32.1	1.8	0	0	0	1	...	0	0	0	1	0	0	0	0	0	0
1	2017	34948	27000	20	61.4	2.1	0	0	1	0	...	0	1	0	0	0	0	0	0	0	0
2	2016	49948	6200	555	28.0	5.5	0	0	0	1	...	0	0	1	0	0	0	0	0	0	0
3	2016	61948	16000	325	30.4	4.0	0	0	0	1	...	0	0	0	0	0	0	0	0	0	0
4	2016	73948	4000	325	30.1	4.0	0	0	0	1	...	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13114	2020	35999	500	145	55.4	2.0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
13115	2020	24699	2500	145	55.4	2.0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
13116	2019	30999	11612	145	41.5	2.1	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
13117	2019	37990	2426	145	45.6	2.0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0
13118	2019	54999	2075	145	52.3	2.9	0	0	0	0	...	0	1	0	0	0	0	0	0	0	0

13110 rows × 36 columns

```
from sklearn.model_selection import train_test_split

mercedes_train, mercedes_test = train_test_split(mercedes_prep, train_size = 0.7)
```

```
mercedes_train.shape
```

```
(9177, 36)
```

```
mercedes_test.shape
```

```
(3933, 36)
```

```
from sklearn.linear_model import LinearRegression

tree = LinearRegression()
tree.fit(mercedes_train.drop(columns='price'),mercedes_train['price'])
accuracy = tree.score(mercedes_test.drop(columns='price'),mercedes_test['price'])
print('Accuracy:',accuracy)
```

```
Accuracy: 0.7636114295699339
```

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