In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [ ]:
```
df = pd.read_csv('G:\\Machine Learning\\Datasets\\laptop_price.csv',encoding='latin-1')
df.head()
```

Out[ ]:

	laptop_ID	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_
0	1	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8GB	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37kg	1
1	2	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8GB	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34kg	
2	3	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8GB	256GB SSD	Intel HD Graphics 620	No OS	1.86kg	
3	4	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16GB	512GB SSD	AMD Radeon Pro 455	macOS	1.83kg	2
4	5	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8GB	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37kg	1

Data Preprocessing

In [ ]:
```
df.shape
```

Out[ ]:
```
(1303, 13)
```

In [ ]:
```
# Removing ID colounm
df = df.drop(['laptop_ID'], axis=1)
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_euros
0	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8GB	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37kg	1339.69
1	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8GB	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34kg	898.94
2	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8GB	256GB SSD	Intel HD Graphics 620	No OS	1.86kg	575.00
3	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16GB	512GB SSD	AMD Radeon Pro 455	macOS	1.83kg	2537.45
4	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8GB	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37kg	1803.60

In [ ]:
```
print("Company =", len(df["Company"].unique()))
print("Product =", len(df["Product"].unique()))
print("TypeName =", len(df["TypeName"].unique()))
print("Inches =", len(df["Inches"].unique()))
print("ScreenResolution =", len(df["ScreenResolution"].unique()))
print("Cpu =", len(df["Cpu"].unique()))
print("Ram =", len(df["Ram"].unique()))
print("Memory =", len(df["Memory"].unique()))
print("Gpu =", len(df["Gpu"].unique()))
print("OpSys =", len(df["OpSys"].unique()))
print("Weight =", len(df["Weight"].unique()))
```

```
Company = 19
Product = 618
TypeName = 6
Inches = 18
ScreenResolution = 40
Cpu = 118
Ram = 9
Memory = 39
Gpu = 110
OpSys = 9
Weight = 179
```

1. Data Cleaning

In [ ]:
```
p = []
for i in df["Price_euros"]:
    p.append(i*float(300.85))

df["Price_rupee"] = p
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_euros	Pric
0	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8GB	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37kg	1339.69	403
1	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8GB	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34kg	898.94	270
2	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8GB	256GB SSD	Intel HD Graphics 620	No OS	1.86kg	575.00	172
3	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16GB	512GB SSD	AMD Radeon Pro 455	macOS	1.83kg	2537.45	763
4	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8GB	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37kg	1803.60	542

In [ ]:
```
df['Memory_Size'] = df["Memory"].str.split(" ").str.get(0)
df['Memory_Type'] = df["Memory"].str.split(" ").str.get(1)
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_euros	Pric
0	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8GB	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37kg	1339.69	403
1	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8GB	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34kg	898.94	270
2	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8GB	256GB SSD	Intel HD Graphics 620	No OS	1.86kg	575.00	172
3	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16GB	512GB SSD	AMD Radeon Pro 455	macOS	1.83kg	2537.45	763
4	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8GB	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37kg	1803.60	542

In [ ]:
```
df["Memory_Size"].unique()
```

Out[ ]:
```
array(['128GB', '256GB', '512GB', '500GB', '1TB', '32GB', '64GB', '2TB',
       '1.0TB', '16GB', '180GB', '240GB', '8GB', '508GB'], dtype=object)
```

In [ ]:
```
j = []
for i in df["Memory_Size"]:
    if "GB" in i:
        j.append(int(i.replace("GB", "")))
    else:
```

```
        j.append(float(i.replace("TB", ""))*float(1024))

df["Memory_Size"] = j
df["Memory_Size"] = df["Memory_Size"].astype(int)
df
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weigh
0	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8GB	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37k
1	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8GB	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34k
2	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8GB	256GB SSD	Intel HD Graphics 620	No OS	1.86k
3	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16GB	512GB SSD	AMD Radeon Pro 455	macOS	1.83k
4	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8GB	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37k
...	...	...	...	...	...	...	...	...	...	...	.
1298	Lenovo	Yoga 500-14ISK	2 in 1 Convertible	14.0	IPS Panel Full HD / Touchscreen 1920x1080	Intel Core i7 6500U 2.5GHz	4GB	128GB SSD	Intel HD Graphics 520	Windows 10	1.8k
1299	Lenovo	Yoga 900-13ISK	2 in 1 Convertible	13.3	IPS Panel Quad HD+ / Touchscreen 3200x1800	Intel Core i7 6500U 2.5GHz	16GB	512GB SSD	Intel HD Graphics 520	Windows 10	1.3k
1300	Lenovo	IdeaPad 100S-14IBR	Notebook	14.0	1366x768	Intel Celeron Dual Core N3050 1.6GHz	2GB	64GB Flash Storage	Intel HD Graphics	Windows 10	1.5k
1301	HP	15-AC110nv (i7-6500U/6GB/1TB/Radeon	Notebook	15.6	1366x768	Intel Core i7 6500U 2.5GHz	6GB	1TB HDD	AMD Radeon R5 M330	Windows 10	2.19k
1302	Asus	X553SA-XX031T (N3050/4GB/500GB/W10)	Notebook	15.6	1366x768	Intel Celeron Dual Core N3050 1.6GHz	4GB	500GB HDD	Intel HD Graphics	Windows 10	2.2k

1303 rows × 15 columns

In [ ]:
```
# Convert 'Ram' column to string type if it's not already
df["Ram"] = df["Ram"].astype(str)

# Perform string manipulation
df["Ram"] = df["Ram"].str.split("G").str.get(0).astype(int)
df["Inches"] = df["Inches"].astype(float)
df["Weight"] = df["Weight"].str.replace("kg", "").astype(float)
```

In [ ]:
```
df.to_csv('Saved_Laptop_data.csv')
```

In [ ]:
```
df["s"] = df["ScreenResolution"].str.split().str[-1].str.split("x")
df["x_res"] = df["s"].str[0].astype(int)
df["y_res"] = df["s"].str[1].astype(int)
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_euros	Pric
0	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 2.3GHz	8	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37	1339.69	4030
1	Apple	Macbook Air	Ultrabook	13.3	1440x900	Intel Core i5 1.8GHz	8	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34	898.94	2704
2	HP	250 G6	Notebook	15.6	Full HD 1920x1080	Intel Core i5 7200U 2.5GHz	8	256GB SSD	Intel HD Graphics 620	No OS	1.86	575.00	1729
3	Apple	MacBook Pro	Ultrabook	15.4	IPS Panel Retina Display 2880x1800	Intel Core i7 2.7GHz	16	512GB SSD	AMD Radeon Pro 455	macOS	1.83	2537.45	7633
4	Apple	MacBook Pro	Ultrabook	13.3	IPS Panel Retina Display 2560x1600	Intel Core i5 3.1GHz	8	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37	1803.60	5426

In [ ]:
```
df["PPi"] = (((df["x_res"]**2 + df["y_res"]**2)**(1/2))/df["Inches"]).astype(float)
df["ScreenResolution"] = (df["x_res"]*df["y_res"]).astype(int)
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Memory	Gpu	OpSys	Weight	Price_euros	Pric
0	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 2.3GHz	8	128GB SSD	Intel Iris Plus Graphics 640	macOS	1.37	1339.69	4030
1	Apple	Macbook Air	Ultrabook	13.3	1296000	Intel Core i5 1.8GHz	8	128GB Flash Storage	Intel HD Graphics 6000	macOS	1.34	898.94	2704
2	HP	250 G6	Notebook	15.6	2073600	Intel Core i5 7200U 2.5GHz	8	256GB SSD	Intel HD Graphics 620	No OS	1.86	575.00	1729
3	Apple	MacBook Pro	Ultrabook	15.4	5184000	Intel Core i7 2.7GHz	16	512GB SSD	AMD Radeon Pro 455	macOS	1.83	2537.45	7633
4	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 3.1GHz	8	256GB SSD	Intel Iris Plus Graphics 650	macOS	1.37	1803.60	5426

Pixel Density Formula

$$pixel\ density = \frac{\sqrt{width^2 + lenght^2}}{screen\ size\ (diagonal)}$$

In [ ]:
```
df.drop(["Memory", "Price_euros", "s", "x_res", "y_res"], axis=1, inplace=True)
df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Gpu	OpSys	Weight	Price_rupee	Memory_Size
0	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 2.3GHz	8	Intel Iris Plus Graphics 640	macOS	1.37	403045.7365	128
1	Apple	Macbook Air	Ultrabook	13.3	1296000	Intel Core i5 1.8GHz	8	Intel HD Graphics 6000	macOS	1.34	270446.0990	128
2	HP	250 G6	Notebook	15.6	2073600	Intel Core i5 7200U 2.5GHz	8	Intel HD Graphics 620	No OS	1.86	172988.7500	256
3	Apple	MacBook Pro	Ultrabook	15.4	5184000	Intel Core i7 2.7GHz	16	AMD Radeon Pro 455	macOS	1.83	763391.8325	512
4	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 3.1GHz	8	Intel Iris Plus Graphics 650	macOS	1.37	542613.0600	256

2. Identifying and Removing Outliers

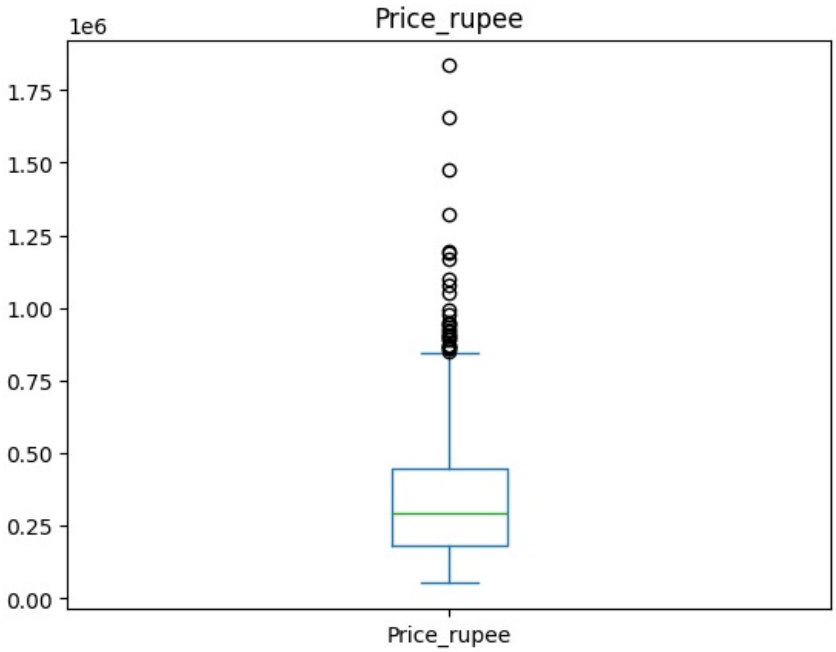
In [ ]:
```
df.describe()
```

Out[ ]:

	Inches	ScreenResolution	Ram	Weight	Price_rupee	Memory_Size	PPi
count	1303.000000	1.303000e+03	1303.000000	1303.000000	1.303000e+03	1303.000000	1303.000000
mean	15.017191	2.168807e+06	8.382195	2.038734	3.380612e+05	447.809670	146.635987
std	1.426304	1.391292e+06	5.084665	0.665475	2.102969e+05	366.037159	43.121345
min	10.100000	1.049088e+06	2.000000	0.690000	5.234790e+04	8.000000	90.583402
25%	14.000000	1.440000e+06	4.000000	1.500000	1.802092e+05	256.000000	127.335675
50%	15.600000	2.073600e+06	8.000000	2.040000	2.939305e+05	256.000000	141.211998
75%	15.600000	2.073600e+06	8.000000	2.300000	4.476287e+05	512.000000	157.350512
max	18.400000	8.294400e+06	64.000000	4.700000	1.834884e+06	2048.000000	352.465147

In [ ]:
```
df["Price_rupee"].plot(kind="box", title="Price_rupee")
```

Out[ ]:
```
<Axes: title={'center': 'Price_rupee'}>
```

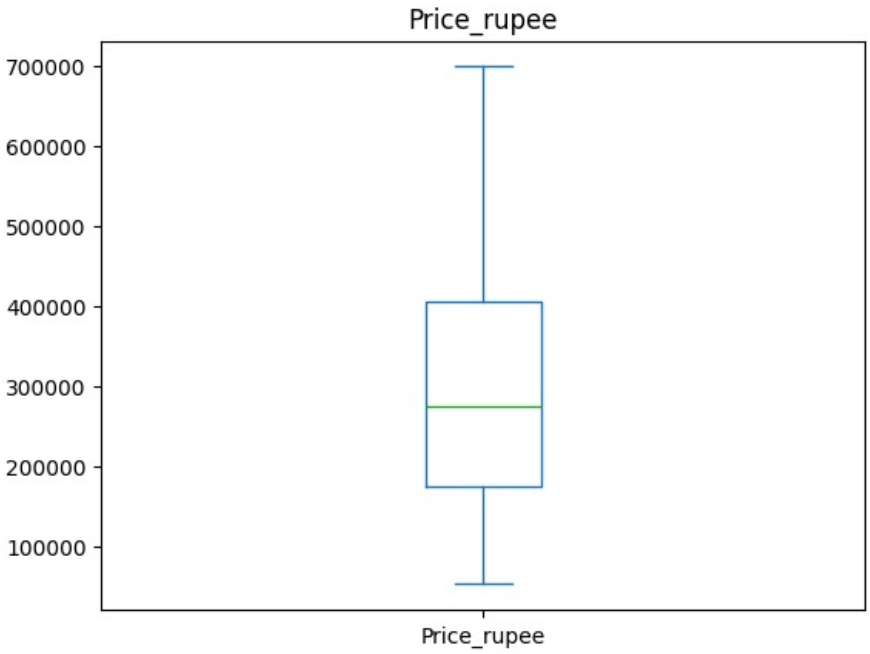


In [ ]:
```
len(df[df["Price_rupee"]>7.0e5])
```

Out[ ]:
```
83
```

In [ ]:
```
df = df[df["Price_rupee"]<7.0e5].reset_index(drop=True)
df["Price_rupee"].plot(kind="box", title="Price_rupee")
```

Out[ ]: <Axes: title={'center': 'Price_rupee'}>



In [ ]:
```
df.shape
```

Out[ ]: (1220, 14)

3. Data Trasformation

In [ ]:
```
df.columns
```

Out[ ]:
```
Index(['Company', 'Product', 'TypeName', 'Inches', 'ScreenResolution', 'Cpu',
       'Ram', 'Gpu', 'OpSys', 'Weight', 'Price_rupee', 'Memory_Size',
       'Memory_Type', 'PPi'],
      dtype='object')
```

In [ ]:
```
# Seprate dependend and independend veriables

x = df.loc[:,['Company', 'Product', 'TypeName', 'Inches', 'ScreenResolution', 'Cpu',
       'Ram', 'Gpu', 'OpSys', 'Weight', 'Memory_Size', 'Memory_Type', 'PPi']]

y = df.loc[:,['Price_rupee',]]
```

In [ ]:
```
from sklearn.preprocessing import OneHotEncoder
ohe = OneHotEncoder()
ohe.fit(x[['Company', 'Product', 'TypeName', 'Cpu', 'Gpu', 'OpSys', 'Memory_Type']])
```

Out[ ]:
```
▾ OneHotEncoder
OneHotEncoder()
```

In [ ]:
```
from sklearn.compose import make_column_transformer
column_trans = make_column_transformer((OneHotEncoder(categories=ohe.categories_), ['Company', 'Product', 'Typel
                                                                                    'Gpu', 'OpSys', 'Memory_Type']), re

df.head()
```

Out[ ]:

	Company	Product	TypeName	Inches	ScreenResolution	Cpu	Ram	Gpu	OpSys	Weight	Price_rupee	Memory_Size
0	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 2.3GHz	8	Intel Iris Plus Graphics 640	macOS	1.37	403045.7365	128
1	Apple	Macbook Air	Ultrabook	13.3	1296000	Intel Core i5 1.8GHz	8	Intel HD Graphics 6000	macOS	1.34	270446.0990	128
2	HP	250 G6	Notebook	15.6	2073600	Intel Core i5 7200U 2.5GHz	8	Intel HD Graphics 620	No OS	1.86	172988.7500	256
3	Apple	MacBook Pro	Ultrabook	13.3	4096000	Intel Core i5 3.1GHz	8	Intel Iris Plus Graphics 650	macOS	1.37	542613.0600	256
4	Acer	Aspire 3	Notebook	15.6	1049088	AMD A9-Series 9420 3GHz	4	AMD Radeon R5	Windows 10	2.10	120340.0000	500

Model Selection

1. Decision Tree

In [ ]:
```
from sklearn.tree import DecisionTreeRegressor
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score
model = DecisionTreeRegressor()
X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=42)
pipe = make_pipeline(column_trans, model)
pipe.fit(X_train, y_train)
y_pred = pipe.predict(X_test)
acc = r2_score(y_test, y_pred)
print("Accuracy: ",acc)
```

```
Accuracy:  0.6932153907405411
```

In [ ]:
```
scores=[]
for i in range(1000):
    X_train,X_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=i)
    DTR = DecisionTreeRegressor()
    pipe=make_pipeline(column_trans,DTR)
    pipe.fit(X_train,y_train)
    y_pred=pipe.predict(X_test)
    scores.append(r2_score(y_test,y_pred))
```

In [ ]:
```
np.argmax(scores)
```

Out[ ]:
```
702
```

In [ ]:
```
scores[np.argmax(scores)]
```

Out[ ]:
```
0.8285524748942718
```

In [ ]:
```
X_train,X_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=np.argmax(scores))
DTR = DecisionTreeRegressor()
pipe=make_pipeline(column_trans,DTR)
pipe.fit(X_train,y_train)
y_pred=pipe.predict(X_test)
r2_score(y_test,y_pred)
```

Out[ ]:
```
0.8166504627885264
```

In [ ]:
```
# Save the model for use in future
import pickle
pickle.dump(pipe, open("LaptopPricePrediction_With DTR (copy).pkl", "wb"))
```

In [ ]:
```
pipe.predict(pd.DataFrame(columns=['Company', 'Product', 'TypeName', 'Inches', 'ScreenResolution', 'Cpu',
                                   'Ram', 'Gpu', 'OpSys', 'Weight', 'Memory_Size', 'Memory_Type', 'PPi'],
                          data=np.array(['Apple','Macbook Air','Ultrabook',13.3, '1296000', 'Intel Core i5 1.8GH
                                         'Intel HD Graphics 6000', 'macOS', 1.34, 128, 'Flash', 127.677940]).re
```

Out[ ]: array([270446.099])

In [ ]:
```
prediction = pipe.predict(pd.DataFrame(columns=['Company', 'Product', 'TypeName', 'Inches', 'ScreenResolution',
                                'Ram', 'Gpu', 'OpSys', 'Weight', 'Memory_Size', 'Memory_Type', 'PPi'],
                        data=np.array(['Apple','Macbook Air','Ultrabook',13.3, '1440900', 'Intel Core i5 1.8GH
                                       'Intel HD Graphics 6000', 'macOS', 1.34, 128, 'SSD', 127.677940]).resha
```

In [ ]:
```
print(str(np.round(prediction[0],2)))
```

```
449770.75
```

2. Random Forest

In [ ]:
```
from sklearn.ensemble import RandomForestRegressor
model = RandomForestRegressor()
X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=42)
pipe2 = make_pipeline(column_trans, model)
pipe2.fit(X_train, y_train)
y_pred = pipe2.predict(X_test)
acc = r2_score(y_test, y_pred)
print("Accuracy: ",acc)
```

```
C:\Users\DELL\AppData\Roaming\Python\Python311\site-packages\sklearn\base.py:1152: DataConversionWarning: A colu
mn-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example u
sing ravel().
  return fit_method(estimator, *args, **kwargs)
Accuracy:  0.8164368031754115
```

In [ ]:
```
# Save the model for use in future
import pickle
pickle.dump(pipe2, open("LaptopPricePrediction.pkl", "wb"))
```

Created by: Abdul Mannan