

```
import pandas as pd
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn import metrics
from sklearn.metrics import f1_score
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
from sklearn.metrics import root_mean_squared_error
from bayes_opt import BayesianOptimization
```

```
#df = pd.read_csv('../data/sample_submission.csv')
df = pd.read_csv('../data/data.csv', sep=';', encoding='latin1')
print(df)
```

	Id	Category	Manufacturer	Model	Prod. year	Gear box type	\
	0	2680	Jeep	HYUNDAI	H1	2014	Automatic
	1	5960	Sedan	MITSUBISHI	Mirage	2002	Automatic
	2	2185	Jeep	HYUNDAI	Santa FE	2014	Automatic
	3	15905	Sedan	MERCEDES-BENZ	E 260	1992	Manual
	4	15337	Universal	HONDA	FIT	2015	Automatic
	...	...	...	...	...	...	...
	16346	19198	Jeep	TOYOTA	RAV 4	2015	Automatic
	16347	3583	Sedan	TOYOTA	Prius	2009	Automatic
	16348	18497	Jeep	SSANGYONG	REXTON	2015	Automatic
	16349	4565	Goods wagon	OPEL	Combo	2011	Manual
	16350	11586	Sedan	FORD	Fusion	2013	Automatic

	Leather interior	Fuel type	Engine volume	Drive wheels	Cylinders	\
	0	Yes	Diesel	2.5	Front	4
	1	No	Petrol	1.8	Front	4
	2	Yes	Diesel	2	Front	4
	3	No	CNG	2.6	Rear	6
	4	Yes	Hybrid	1.5	Front	4
	...	...	...	...	...	...
	16346	Yes	Petrol	2.5	4x4	4
	16347	Yes	Hybrid	1.5	Front	4
	16348	Yes	Diesel	2	Front	4
	16349	No	Diesel	1.3 Turbo	Front	4
	16350	Yes	Hybrid	2	Front	4

	Mileage	Doors	Airbags	Wheel	Color	Sales	Fee	price
	0	74210 km	4	4	Left wheel	Silver	777	22433
	1	160000 km	4	2	Left wheel	White	-	7500
	2	51106 km	4	4	Left wheel	White	639	27284
	3	0 km	4	4	Left wheel	Beige	-	3450
	4	35624 km	4	4	Left wheel	Black	308	26644
	...	...	...	...	...	...	...	...
	16346	149019 km	4	0	Left wheel	Grey	934	28225
	16347	142426 km	4	12	Left wheel	White	746	1882
	16348	123303 km	4	4	Left wheel	Black	765	36219
	16349	95000 km	4	4	Left wheel	White	490	9408
	16350	174619 km	4	0	Left wheel	Grey	640	1646

[16351 rows x 18 columns]

▼ DATOS FALTANTES

```
# verificar datos faltantes
for col in df.columns.to_list():
    calc = (df[col].isna().sum())/df.shape[0]*100
    print(f'{col} missing Values: {calc}%')
```

```
Id missing Values: 0.0%
Category missing Values: 0.0%
Manufacturer missing Values: 0.0%
Model missing Values: 0.0%
Prod. year missing Values: 0.0%
Gear box type missing Values: 0.0%
Leather interior missing Values: 0.0%
Fuel type missing Values: 0.0%
Engine volume missing Values: 0.0%
Drive wheels missing Values: 0.0%
Cylinders missing Values: 0.0%
Mileage missing Values: 0.0%
Doors missing Values: 0.0%
Airbags missing Values: 0.0%
Wheel missing Values: 0.0%
Color missing Values: 0.0%
Sales Fee missing Values: 0.0%
price missing Values: 0.0%
```

▼ VARIABLES CATEGÓRICAS

▼ ENCODING

```
def label_encoding(dataset, column_name):
    label_encoder = LabelEncoder()
    dataset[column_name] = label_encoder.fit_transform(dataset[column_name])
    return dataset, label_encoder

def frequency_encoding(dataset, col):
    freq = dataset[col].value_counts(normalize=True)
    dataset[col] = dataset[col].map(freq)
    return dataset, freq

df2 = df
def to_zero(n):
    if n == '-': return 0
    return n
```

```
def mileage_km(n):
    return n.replace(' km', '')

def turbo(n):
    if 'Turbo' in n: return 1
    return 0

def engine_volume(n):
    return n.replace(' Turbo', '')

def doors(n):
    if n == '>5': return 6
    return n

df2['Turbo'] = df2['Engine volume'].map(turbo)

df2['Sales Fee'] = df2['Sales Fee'].map(to_zero)
df2['Mileage'] = df2['Mileage'].map(mileage_km)
df2['Engine volume'] = df2['Engine volume'].map(engine_volume)
df2['Doors'] = df2['Doors'].map(doors)

df2.head(20)
```



	Id	Category	Manufacturer	Model	Prod. year	Gear box type	Leather interior	Fuel type	Engine volume	Drive wheels	Cylinders	Mileage	Doors	Airbags	Wheel	Color	Sales Fee	price	Turbo
0	2680	Jeep	HYUNDAI	H1	2014	Automatic	Yes	Diesel	2.5	Front	4	74210	4	4	Left wheel	Silver	777	22433	0
1	5960	Sedan	MITSUBISHI	Mirage	2002	Automatic	No	Petrol	1.8	Front	4	160000	4	2	Left wheel	White	0	7500	0
2	2185	Jeep	HYUNDAI	Santa FE	2014	Automatic	Yes	Diesel	2	Front	4	51106	4	4	Left wheel	White	639	27284	0
3	15905	Sedan	MERCEDES-BENZ	E 260	1992	Manual	No	CNG	2.6	Rear	6	0	4	4	Left wheel	Beige	0	3450	0
4	15337	Universal	HONDA	FIT	2015	Automatic	Yes	Hybrid	1.5	Front	4	35624	4	4	Left wheel	Black	308	26644	0
5	13792	Hatchback	HONDA	FIT	2014	Automatic	Yes	Petrol	1.5	Front	4	78000	4	4	Left wheel	White	501	25638	0
6	12015	Microbus	FORD	Transit	2007	Manual	No	Diesel	2.4	Rear	4	165000	4	2	Left wheel	Blue	0	17249	0
7	307	Sedan	TOYOTA	Camry	2015	Automatic	Yes	Hybrid	2.5	Front	4	35000	4	10	Left wheel	Grey	456	39201	0
8	1054	Sedan	TOYOTA	Camry	2012	Automatic	Yes	Hybrid	2.5	Front	4	156518	4	12	Left wheel	White	781	3607	0
9	7945	Sedan	HYUNDAI	Elantra	2012	Automatic	Yes	Petrol	1.6	Front	4	165294	4	4	Left wheel	Silver	531	16308	0
10	15234	Minivan	MERCEDES-BENZ	Vito	2007	Tiptronic	Yes	Diesel	3.0	Rear	6	250000	4	4	Left wheel	Black	0	30640	1
11	2277	Jeep	LEXUS	RX 450	2010	Automatic	Yes	Hybrid	3.5	4x4	6	167222	4	12	Left wheel	Black	1399	5018	0
12	1660	Sedan	HYUNDAI	Sonata	2016	Automatic	Yes	LPG	2	Front	4	287140	4	4	Left wheel	White	891	18817	0
13	15966	Sedan	FORD	F150	2016	Automatic	Yes	Petrol	3.5	Front	4	33543	4	4	Left wheel	White	1493	126322	0
14	11541	Coupe	HYUNDAI	Genesis	2010	Automatic	Yes	Petrol	3.8	Front	4	151977	4	4	Left wheel	Blue	1511	16621	0
15	1579	Jeep	TOYOTA	RAV 4	2010	Variator	Yes	Petrol	2	4x4	4	167300	6	8	Left wheel	Blue	0	23207	0
16	3011	Jeep	HYUNDAI	Tucson	2016	Automatic	Yes	Diesel	2	Front	4	27243	4	4	Left wheel	Grey	891	29633	0
17	4573	Jeep	MERCEDES-BENZ	ML 350	2009	Automatic	Yes	Diesel	3.5	4x4	6	274088	4	12	Left wheel	Black	1624	6272	0
18	6342	Jeep	MERCEDES-BENZ	GL 450	2006	Automatic	Yes	LPG	4.5	4x4	6	181000	4	6	Left wheel	Black	0	21000	1
19	15558	Sedan	HYUNDAI	Sonata	2015	Automatic	Yes	Petrol	2	Front	4	59150	4	4	Left wheel	Grey	765	42692	0

```
df2, freq_category = frequency_encoding(df2, 'Category')
df2, freq_manufacturer = frequency_encoding(df2, 'Manufacturer')
df2, freq_model = frequency_encoding(df2, 'Model')
# Prod. Year
df2, freq_gear_box_type = frequency_encoding(df2, 'Gear box type')
df2, label_leather_interior = label_encoding(df2, 'Leather interior')
df2, freq_fuel_type = frequency_encoding(df2, 'Fuel type')
# Engine volume: quitar el turbo y crear variable aparte
df2, freq_drive_wheels = frequency_encoding(df2, 'Drive wheels')
# Cylinders
df2, freq_mileage = frequency_encoding(df2, 'Mileage') # quitar km
# Doors: cambiar >5 por 4
# Airbags
df2, freq_wheel = frequency_encoding(df2, 'Wheel')
df2, freq_color = frequency_encoding(df2, 'Color')
# Sales Fee: cambiar '-' por '0'
df2.head()
```



	Id	Category	Manufacturer	Model	Prod. year	Gear box type	Leather interior	Fuel type	Engine volume	Drive wheels	Cylinders	Mileage	Doors	Airbags	Wheel	Color	Sales Fee	price	Turbo
0	2680	0.287567	0.196869	0.022567	2014	0.702832	1	0.211363	2.5	0.670907	4	0.000061	4	4	0.922512	0.195951	777	22433	0
1	5960	0.453183	0.015106	0.000428	2002	0.702832	0	0.528286	1.8	0.670907	4	0.006483	4	2	0.922512	0.233380	0	7500	0
2	2185	0.287567	0.196869	0.027521	2014	0.702832	1	0.211363	2	0.670907	4	0.000122	4	4	0.922512	0.233380	639	27284	0
3	15905	0.453183	0.105315	0.000061	1992	0.096875	0	0.024524	2.6	0.118097	6	0.036817	4	4	0.922512	0.006850	0	3450	0
4	15337	0.018592	0.050028	0.022690	2015	0.702832	1	0.185065	1.5	0.670907	4	0.000061	4	4	0.922512	0.261941	308	26644	0

OUTLIERS

```
for col in df2.columns:
    df2[col] = pd.to_numeric(df2[col])

# Crear características adicionales basadas en correlaciones y relaciones avanzadas
df2['Mileage_Engine_ratio'] = df2['Mileage'] / (df2['Engine volume'] + 1)
df2['Age'] = 2024 - df2['Prod. year']
df2['Mileage_Age'] = df2['Mileage'] * df2['Age']
df2['Mileage_Engine_Age'] = df2['Mileage'] * df2['Engine volume'] * df2['Age']
df2['Mileage_Age_squared'] = (df2['Mileage'] * df2['Age']) ** 2
df2['log_Mileage'] = np.log1p(df2['Mileage'])
df2['Age_SalesFee'] = df2['Age'] * df2['Sales Fee']
df2['Mileage_Age_Log'] = np.log1p(df2['Mileage_Age'])

# Tratar con outliers
def cuantificaOutliers(dataset):
    for col in dataset.columns:
        q1, q3 = np.percentile(dataset[col],[25,75])
        iqr = q3-q1
        lower_bound = q1 - (1.5*iqr)
        upper_bound = q3 + (1.5*iqr)
        outlier = dataset[(dataset[col]<lower_bound)|(dataset[col]>upper_bound)]
        print(col, ' ', outlier.shape[0], ' ', outlier.shape[0]/dataset.shape[0]*100, '%')

cuantificaOutliers(df2)
```



Id	0	0.0 %
Category	0	0.0 %
Manufacturer	0	0.0 %
Model	0	0.0 %
Prod. year	824	5.039447128615987 %
Gear box type	0	0.0 %
Leather interior	0	0.0 %
Fuel type	0	0.0 %
Engine volume	1184	7.241147330438505 %
Drive wheels	0	0.0 %
Cylinders	4140	25.31955232095896 %
Mileage	2015	12.323405296312153 %
Doors	763	4.666381261084949 %

```
Airbags    0    0.0 %
Wheel    1267    7.7487615436364745 %
Color    0    0.0 %
Sales Fee    136    0.831753409577396 %
price    901    5.510366338450248 %
Turbo    1618    9.89541924041343 %
Mileage_Engine_ratio    2058    12.586386153752063 %
Age    824    5.039447128615987 %
Mileage_Age    2240    13.699467922451225 %
Mileage_Engine_Age    2150    13.149042871995597 %
Mileage_Age_squared    3023    18.488165861415204 %
log_Mileage    2015    12.323405296312153 %
Age_SalesFee    548    3.3514769738853896 %
Mileage_Age_Log    2240    13.699467922451225 %

def Modifica_Outliers (dataset,columna):
    q1, q3 = np.percentile(dataset[columna], [25, 75])
    # Calculate the interquartile range
    iqr = q3 - q1
    # Calculate the lower and upper bounds
    lower_limit = q1 - (1.5 * iqr)
    upper_limit = q3 + (1.5 * iqr)

    dataset[columna] = np.where(dataset[columna]>upper_limit,upper_limit,np.where(dataset[columna]<lower_limit,lower_limit,dataset[columna]))
    return (dataset)

Modifica_Outliers(df2,'Engine volume')
Modifica_Outliers(df2,'Prod. year')
Modifica_Outliers(df2,'Mileage')
Modifica_Outliers(df2,'Sales Fee')
Modifica_Outliers(df2,'Mileage_Engine_ratio')
Modifica_Outliers(df2,'Age')
Modifica_Outliers(df2,'Mileage_Age')
Modifica_Outliers(df2,'Mileage_Engine_Age')
Modifica_Outliers(df2,'Mileage_Age_squared')
Modifica_Outliers(df2,'log_Mileage')
Modifica_Outliers(df2,'Age_SalesFee')
Modifica_Outliers(df2,'Mileage_Age_Log')
cuantificaOutliers(df2)

➡ Id    0    0.0 %
Category    0    0.0 %
Manufacturer    0    0.0 %
Model    0    0.0 %
Prod. year    0    0.0 %
Gear box type    0    0.0 %
Leather interior    0    0.0 %
Fuel type    0    0.0 %
Engine volume    0    0.0 %
Drive wheels    0    0.0 %
Cylinders    4140    25.31955232095896 %
Mileage    0    0.0 %
Doors    763    4.666381261084949 %
Airbags    0    0.0 %
Wheel    1267    7.7487615436364745 %
Color    0    0.0 %
Sales Fee    0    0.0 %
```

```
price    901    5.510366338450248 %
Turbo    1618   9.89541924041343 %
Mileage_Engine_ratio  0    0.0 %
Age      0    0.0 %
Mileage_Age      0    0.0 %
Mileage_Engine_Age  0    0.0 %
Mileage_Age_squared  0    0.0 %
log_Mileage      0    0.0 %
Age_SalesFee     0    0.0 %
Mileage_Age_Log  0    0.0 %
```

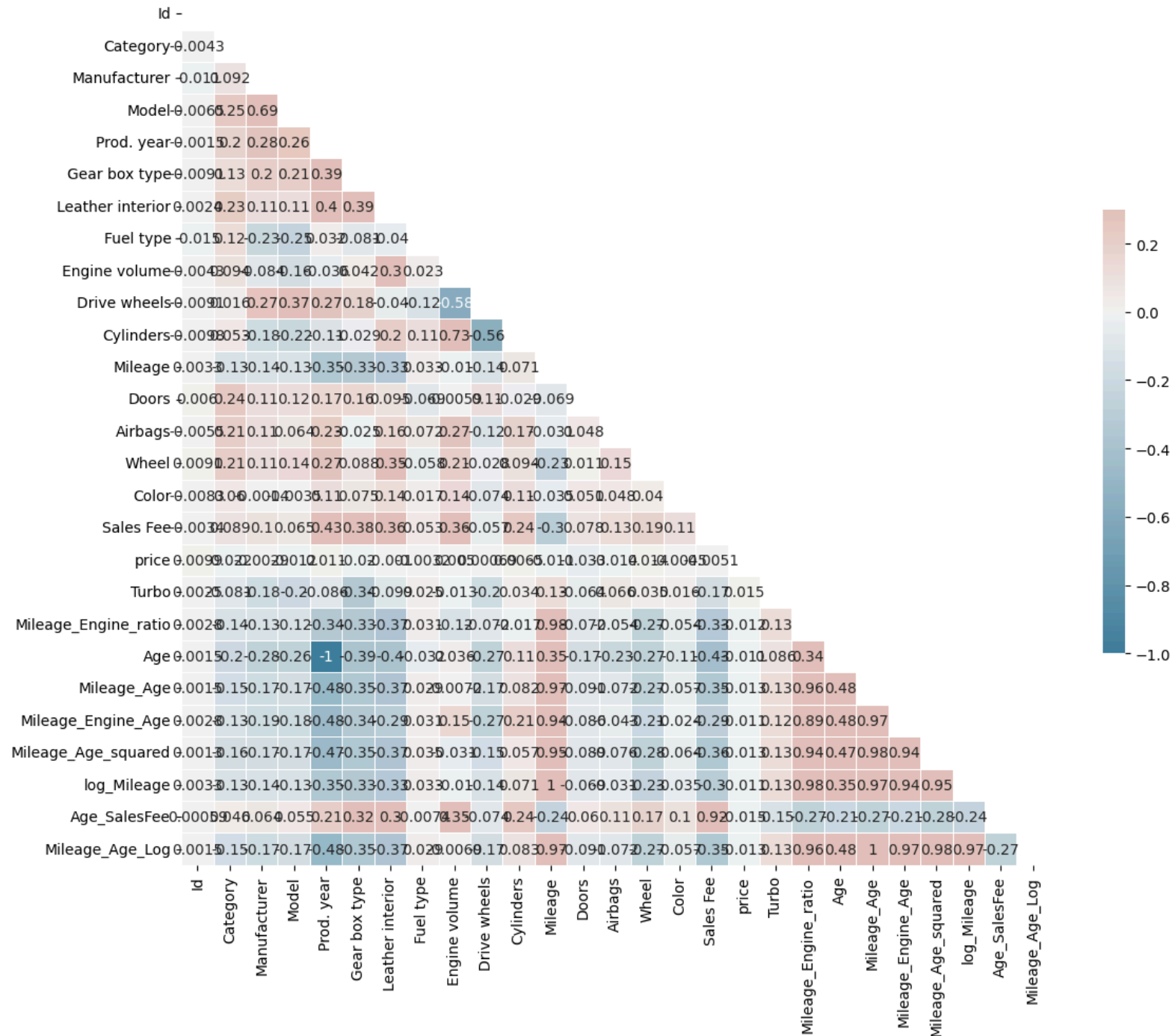
✓ ANÁLISIS DE CORRELACIÓN

```
# Realizar un análisis de correlación
corr = df2.corr(method='pearson')
mask = np.triu(np.ones_like(corr, dtype=bool))
f, ax = plt.subplots(figsize=(11,9))
cmap = sns.diverging_palette(230, 20, as_cmap=True)

plt.tight_layout()
sns.heatmap(corr, mask=mask, cmap=cmap, vmax=.3, center=0, square=True, linewidths=.5, cbar_kws={'shrink':0.5}, annot=True)
```



<Axes: >





```
correlations = df2.corr()['price'].abs().sort_values(ascending=False)
print("Correlación con la variable objetivo (Curado):\n", correlations)
```

↗

Correlación con la variable objetivo (Curado):	
price	1.000000
Doors	0.032986
Category	0.021632
Gear box type	0.020325
Turbo	0.015388
Age_SalesFee	0.014557
Wheel	0.013929
Airbags	0.013830
Mileage_Age_Log	0.013287
Mileage_Age	0.013278
Mileage_Age_squared	0.013014
Mileage_Engine_ratio	0.012200
Model	0.012108
Mileage_Engine_Age	0.011147
Prod. year	0.010756
Age	0.010756
log_Mileage	0.010523
Mileage	0.010522
Id	0.009915
Cylinders	0.006525
Sales Fee	0.005070
Engine volume	0.005026
Color	0.004539
Fuel type	0.003239
Manufacturer	0.002938
Leather interior	0.000998
Drive wheels	0.000685
Name: price, dtype: float64	

✓ VARIABLES

```
df3 = df2
df3 = df3.drop('Engine volume', axis=1)
df3 = df3.drop('Color', axis=1)
df3 = df3.drop('Fuel type', axis=1)
df3 = df3.drop('Manufacturer', axis=1)
df3 = df3.drop('Leather interior', axis=1)
df3 = df3.drop('Drive wheels', axis=1)
df3.head()
```



	Id	Category	Model	Prod. year	Gear box type	Cylinders	Mileage	Doors	Airbags	Wheel	...	price	Turbo	Mileage_Engine_ratio	Age	Mileage_Age	Mileage_Engine_Age	Mileage_Age_squared	log_Mileage	Age_SalesFee	Mileage.
0	2680	0.287567	0.022567	2014.0	0.702832	4	0.000061	4	4	0.922512	...	22433	0	0.000017	10.0	0.000612	0.001529	3.740342e-07	0.000061	7770.0	
1	5960	0.453183	0.000428	2002.0	0.702832	4	0.003272	4	2	0.922512	...	7500	0	0.001028	22.0	0.043055	0.099920	7.853073e-04	0.003270	0.0	
2	2185	0.287567	0.027521	2014.0	0.702832	4	0.000122	4	4	0.922512	...	27284	0	0.000041	10.0	0.001223	0.002446	1.496137e-06	0.000122	6390.0	
3	15905	0.453183	0.000061	2000.0	0.096875	6	0.003272	4	4	0.922512	...	3450	0	0.001028	24.0	0.043055	0.099920	7.853073e-04	0.003270	0.0	
4	15337	0.018592	0.022690	2015.0	0.702832	4	0.000061	4	4	0.922512	...	26644	0	0.000024	9.0	0.000550	0.000826	3.029677e-07	0.000061	2772.0	

5 rows × 21 columns



```
df4 = df3
y = df4['price']
x = df4.drop('price', axis=1)
```

## ✓ MODELO

```
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error

# Separar Dataset en Training y Testing Sets
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=42)

# Definir función para calcular el RMSE
def root_mean_squared_error(y_true, y_pred):
    return np.sqrt(mean_squared_error(y_true, y_pred))

# Función de evaluación para Random Forest
def random_forest_evaluate(max_depth, n_estimators, max_features, min_samples_split, min_samples_leaf):
    model = RandomForestRegressor(
        max_depth=int(max_depth),
        n_estimators=int(n_estimators),
        max_features=max_features,
        min_samples_split=int(min_samples_split),
        min_samples_leaf=int(min_samples_leaf),
        random_state=42,
        n_jobs=-1 # Usar todos los procesadores disponibles
    )
    model.fit(x_train, y_train)
    y_val_pred = model.predict(x_test)
    return -root_mean_squared_error(y_test, y_val_pred)

# Definir límites para los parámetros de optimización
param_bounds = {
    'max_depth': (5, 15),
```

```
'n_estimators': (100, 1000),
'max_features': (0.1, 0.9),
'min_samples_split': (2, 10),
'min_samples_leaf': (1, 5)
}

# Ejecutar optimización bayesiana
optimizer = BayesianOptimization(f=random_forest_evaluate, pbounds=param_bounds, random_state=42, verbose=2)
optimizer.maximize(init_points=10, n_iter=25)


# Obtener los mejores parámetros
best_params = optimizer.max['params']
best_params['max_depth'] = int(best_params['max_depth'])
best_params['n_estimators'] = int(best_params['n_estimators'])
best_params['min_samples_split'] = int(best_params['min_samples_split'])
best_params['min_samples_leaf'] = int(best_params['min_samples_leaf'])

print("Mejores parámetros encontrados:")
print(best_params)

# Inicializar y entrenar el modelo con los mejores parámetros
rf_regressor = RandomForestRegressor(**best_params, random_state=42, n_jobs=-1)
rf_regressor.fit(x_train, y_train)

# Hacer predicciones
y_pred = rf_regressor.predict(x_test)

# Calcular y mostrar el RMSE en el conjunto de prueba
test_rmse = root_mean_squared_error(y_test, y_pred)
print("RMSE en el conjunto de prueba:", test_rmse)
```



iter	target	max_depth	max_fe...	min_sa...	min_sa...	n_esti...
1	-4.601e+0	8.745	0.8606	3.928	6.789	240.4
2	-4.601e+0	6.56	0.1465	4.465	6.809	737.3
3	-4.601e+0	5.206	0.8759	4.33	3.699	263.6
4	-4.601e+0	6.834	0.3434	3.099	5.456	362.1
5	-4.601e+0	11.12	0.2116	2.169	4.931	510.5
6	-4.601e+0	12.85	0.2597	3.057	6.739	141.8
7	-4.601e+0	11.08	0.2364	1.26	9.591	969.1
8	-4.601e+0	13.08	0.3437	1.391	7.474	496.1
9	-4.601e+0	6.22	0.4961	1.138	9.275	332.9
10	-4.601e+0	11.63	0.3494	3.08	6.374	266.4
11	-4.601e+0	11.05	0.2764	3.503	6.573	266.4
12	-4.601e+0	9.241	0.3112	2.903	9.227	501.6
13	-4.601e+0	11.65	0.7551	4.033	2.074	491.3
14	-4.601e+0	14.66	0.2136	3.67	6.453	233.7
15	-4.601e+0	14.78	0.4378	1.001	9.806	244.4
16	-4.601e+0	11.65	0.6389	1.074	9.89	483.3
17	-4.601e+0	14.97	0.2377	1.001	3.952	279.1
18	-4.601e+0	14.95	0.6384	2.902	7.618	290.8
19	-4.601e+0	13.58	0.236	1.71	7.789	467.7
20	-4.601e+0	5.292	0.7802	2.262	9.488	454.2
21	-4.601e+0	5.097	0.7626	1.211	2.533	287.9
22	-4.601e+0	13.57	0.8057	3.468	2.38	476.6
23	-4.601e+0	11.19	0.6446	1.703	5.403	954.5

	24		-4.601e+0		5.164		0.6146		3.537		9.651		945.8	
	25		-4.601e+0		13.48		0.5109		2.881		3.205		960.5	
	26		-4.601e+0		5.013		0.1334		2.997		3.318		963.0	
	27		-4.601e+0		14.67		0.601		4.2		7.928		957.4	
	28		-4.601e+0		14.04		0.1611		1.156		2.027		955.0	
	29		-4.601e+0		9.92		0.2036		3.635		9.984		474.9	
	30		-4.601e+0		10.25		0.1628		2.738		9.027		490.1	
	31		-4.601e+0		14.54		0.8763		3.859		3.705		244.2	
	32		-4.601e+0		9.454		0.3948		1.651		5.889		247.6	
	33		-4.601e+0		14.89		0.3625		1.008		6.776		273.4	
	34		-4.601e+0		14.91		0.6734		3.518		9.179		282.9	
	35		-4.601e+0		15.0		0.6042		1.42		2.23		482.9	

=====



Mejores parámetros encontrados:  
{'max\_depth': 14, 'max\_features': 0.6042406354962725, 'min\_samples\_leaf': 1, 'min\_samples\_split': 2, 'n\_estimators': 482}  
RMSE en el conjunto de prueba: 460067.035119658

✓ EVALUACIÓN

```
from sklearn.metrics import mean_squared_error, r2_score
```

```
mse = mean_squared_error(y_test, y_pred)
rmse = np.sqrt(mse)
r2 = r2_score(y_test, y_pred)
```

```
print("Root Mean Squared Error (RMSE):", rmse)
print("R^2 Score:", r2)
```


 

Root Mean Squared Error (RMSE): 460067.035119658  
R^2 Score: 0.00016000735176491254

```
from sklearn.model_selection import cross_val_score
```

```
# cross-validation
cv_scores = cross_val_score(rf_regressor, x, y, cv=5, scoring='neg_mean_squared_error')
cv_rmse = np.sqrt(-cv_scores)
```

```
print("Cross-Validated RMSE:", cv_rmse.mean())
```

Cross-Validated RMSE: 143508.4858129176

✓ OUTPUT FILE

```
df_eval = pd.read_csv('../data/Evaluation.csv', sep=';', encoding='latin1')
```

```
df_eval['Turbo'] = df_eval['Engine volume'].map(turbo)
```

```
df_eval['Sales Fee'] = df_eval['Sales Fee'].map(to_zero)
df_eval['Mileage'] = df_eval['Mileage'].map(mileage_km)
```

```
df_eval['Engine volume'] = df_eval['Engine volume'].map(engine_volume)
df_eval['Doors'] = df_eval['Doors'].map(doors)


df_eval['Category'] = df_eval['Category'].map(freq_category).fillna(0)
df_eval['Manufacturer'] = df_eval['Manufacturer'].map(freq_manufacturer)
df_eval['Model'] = df_eval['Model'].map(freq_model)
df_eval['Gear box type'] = df_eval['Gear box type'].map(freq_gear_box_type)
df_eval['Leather interior'] = label_leather_interior.transform(df_eval['Leather interior'])
df_eval['Fuel type'] = df_eval['Fuel type'].map(freq_fuel_type)
df_eval['Drive wheels'] = df_eval['Drive wheels'].map(freq_drive_wheels)
df_eval['Mileage'] = df_eval['Mileage'].map(freq_mileage)
df_eval['Wheel'] = df_eval['Wheel'].map(freq_wheel)
df_eval['Color'] = df_eval['Color'].map(freq_color)

for col in df_eval.columns:
    df_eval[col] = pd.to_numeric(df_eval[col])

# Crear características adicionales basadas en correlaciones y relaciones avanzadas
df_eval['Mileage_Engine_ratio'] = df_eval['Mileage'] / (df_eval['Engine volume'] + 1)
df_eval['Age'] = 2024 - df_eval['Prod. year']
df_eval['Mileage_Age'] = df_eval['Mileage'] * df_eval['Age']
df_eval['Mileage_Engine_Age'] = df_eval['Mileage'] * df_eval['Engine volume'] * df_eval['Age']
df_eval['Mileage_Age_squared'] = (df_eval['Mileage'] * df_eval['Age']) ** 2
df_eval['log_Mileage'] = np.log1p(df_eval['Mileage'])
df_eval['Age_SalesFee'] = df_eval['Age'] * df_eval['Sales Fee']
df_eval['Mileage_Age_Log'] = np.log1p(df_eval['Mileage_Age'])

df_eval = df_eval.drop('Engine volume', axis=1)
df_eval = df_eval.drop('Color', axis=1)
df_eval = df_eval.drop('Fuel type', axis=1)
df_eval = df_eval.drop('Manufacturer', axis=1)
df_eval = df_eval.drop('Leather interior', axis=1)
df_eval = df_eval.drop('Drive wheels', axis=1)

print(df_eval)
```



	Id	Category	Model	Prod. year	Gear box type	Cylinders	\
0	15246	0.453183	0.048560	2014	0.702832	4	
1	5176	0.453183	0.049477	2013	0.702832	4	
2	3143	0.287567	0.002324	2009	0.702832	4	
3	3360	0.287567	0.000550	2011	0.096875	6	
4	3105	0.027093	0.001835	2013	0.702832	4	
...	...	...	...	...	...	...	
2881	17665	0.453183	0.056021	2009	0.702832	4	
2882	6554	0.287567	0.027521	2015	0.702832	4	
2883	18661	0.453183	0.017369	2014	0.702832	4	
2884	6825	0.453183	0.000673	2014	0.702832	4	
2885	11266	0.015779	0.011009	1996	0.096875	6	
	Mileage	Doors	Airbags	Wheel	Sales Fee	Turbo	\
0	0.001590	4	6	0.922512	584	0	
1	0.000795	4	12	0.922512	779	0	
2	NaN	4	4	0.922512	1141	0	
3	0.005321	2	2	0.922512	0	0	
4	0.000306	4	12	0.922512	87	0	
...	...	...	...	...	...	...	
2881	0.000245	4	12	0.922512	746	0	

2882	NaN	4	12	0.922512	900	0
2883	0.003303	4	0	0.077488	0	0
2884	NaN	4	4	0.922512	1053	0