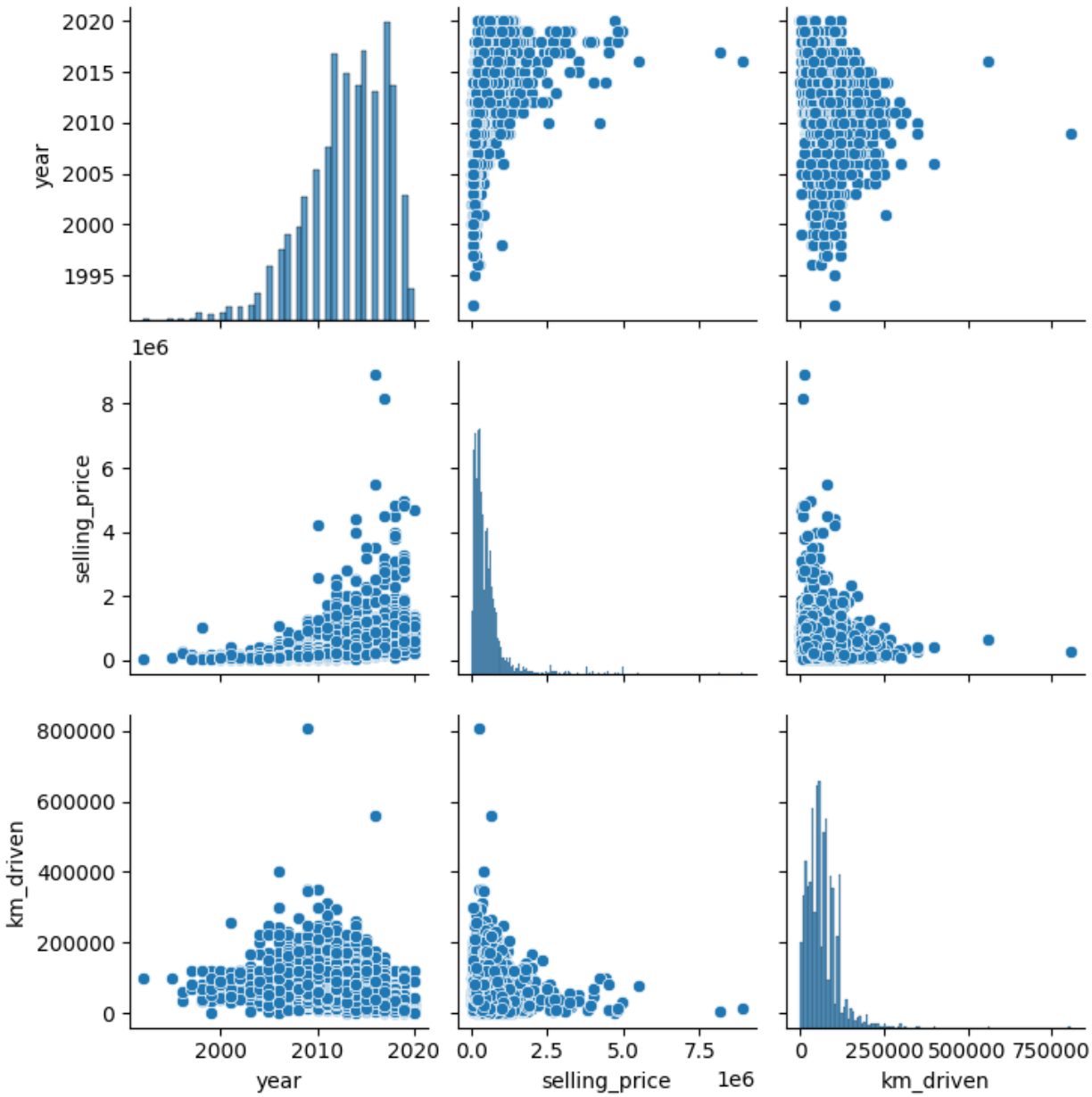
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split,
RandomizedSearchCV, cross_val_score
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor,
GradientBoostingRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error
from scipy.stats import randint

# Load the dataset
file_path = 'car prices.csv'
df = pd.read_csv(file_path)

# Data Exploration
print(df.info())
print(df.describe())
print(df.head())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4340 entries, 0 to 4339
Data columns (total 8 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   name           4340 non-null   object
 1   year           4340 non-null   int64
 2   selling_price  4340 non-null   int64
 3   km_driven      4340 non-null   int64
 4   fuel           4340 non-null   object
 5   seller_type    4340 non-null   object
 6   transmission   4340 non-null   object
 7   owner          4340 non-null   object
dtypes: int64(3), object(5)
memory usage: 271.4+ KB
None
              year  selling_price      km_driven
count  4340.000000   4.340000e+03    4340.000000
mean   2013.090783   5.041273e+05   66215.777419
std       4.215344   5.785487e+05   46644.102194
min    1992.000000   2.000000e+04       1.000000
25%    2011.000000   2.087498e+05   35000.000000
50%    2014.000000   3.500000e+05   60000.000000
75%    2016.000000   6.000000e+05   90000.000000
max    2020.000000   8.900000e+06  806599.000000
                      name  year  selling_price  km_driven    fuel  \
```

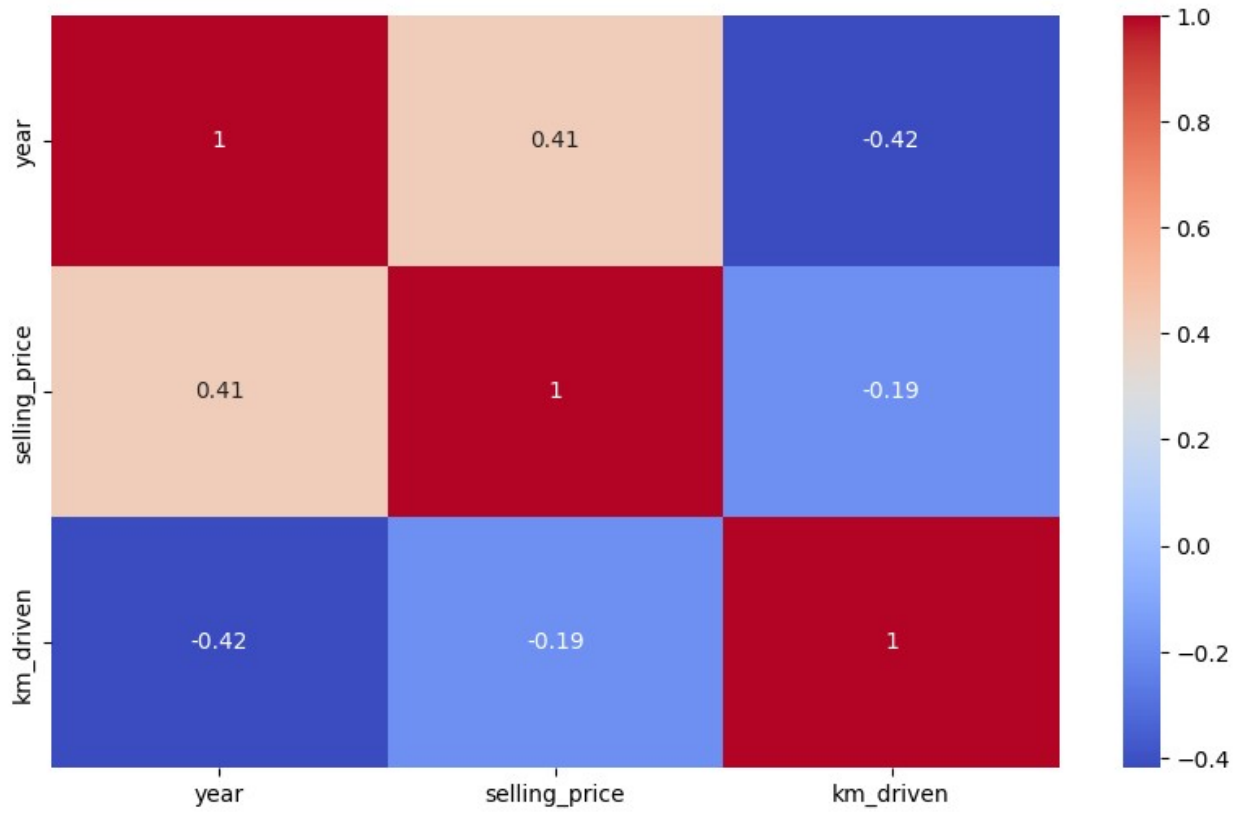
```
0             Maruti 800 AC  2007          60000      70000  Petrol
1  Maruti Wagon R LXI Minor  2007         135000      50000  Petrol
2      Hyundai Verna 1.6 SX  2012         600000     100000  Diesel
3    Datsun RediGO T Option  2017         250000      46000  Petrol
4     Honda Amaze VX i-DTEC  2014         450000     141000  Diesel

  seller_type transmission         owner
0  Individual       Manual   First Owner
1  Individual       Manual   First Owner
2  Individual       Manual   First Owner
3  Individual       Manual   First Owner
4  Individual       Manual  Second Owner
```

```
# Visualizations
plt.figure(figsize=(10, 6))
sns.pairplot(df)
plt.show()
```

```
<Figure size 1000x600 with 0 Axes>
```




```
# Correlation heatmap for numeric columns
plt.figure(figsize=(10, 6))
numeric_cols = df.select_dtypes(include=['int64', 'float64']).columns
sns.heatmap(df[numeric_cols].corr(), annot=True, cmap='coolwarm')
plt.show()
```




```
# Feature Engineering
df['age'] = 2024 - df['year']  # Assuming the current year is 2024
df = df.drop(columns='year')

X = df.drop(columns='selling_price')
y = df['selling_price']

# Identify categorical and numerical columns
categorical_cols = X.select_dtypes(include=['object']).columns
numerical_cols = X.select_dtypes(include=['int64', 'float64']).columns

# Preprocessing pipelines for numerical and categorical data
numerical_transformer = StandardScaler()
categorical_transformer = OneHotEncoder(handle_unknown='ignore')

preprocessor = ColumnTransformer(
    transformers=[
        ('num', numerical_transformer, numerical_cols),
        ('cat', categorical_transformer, categorical_cols)
    ])

# Model pipelines
model_pipeline = Pipeline(steps=[
    ('preprocessor', preprocessor),
```

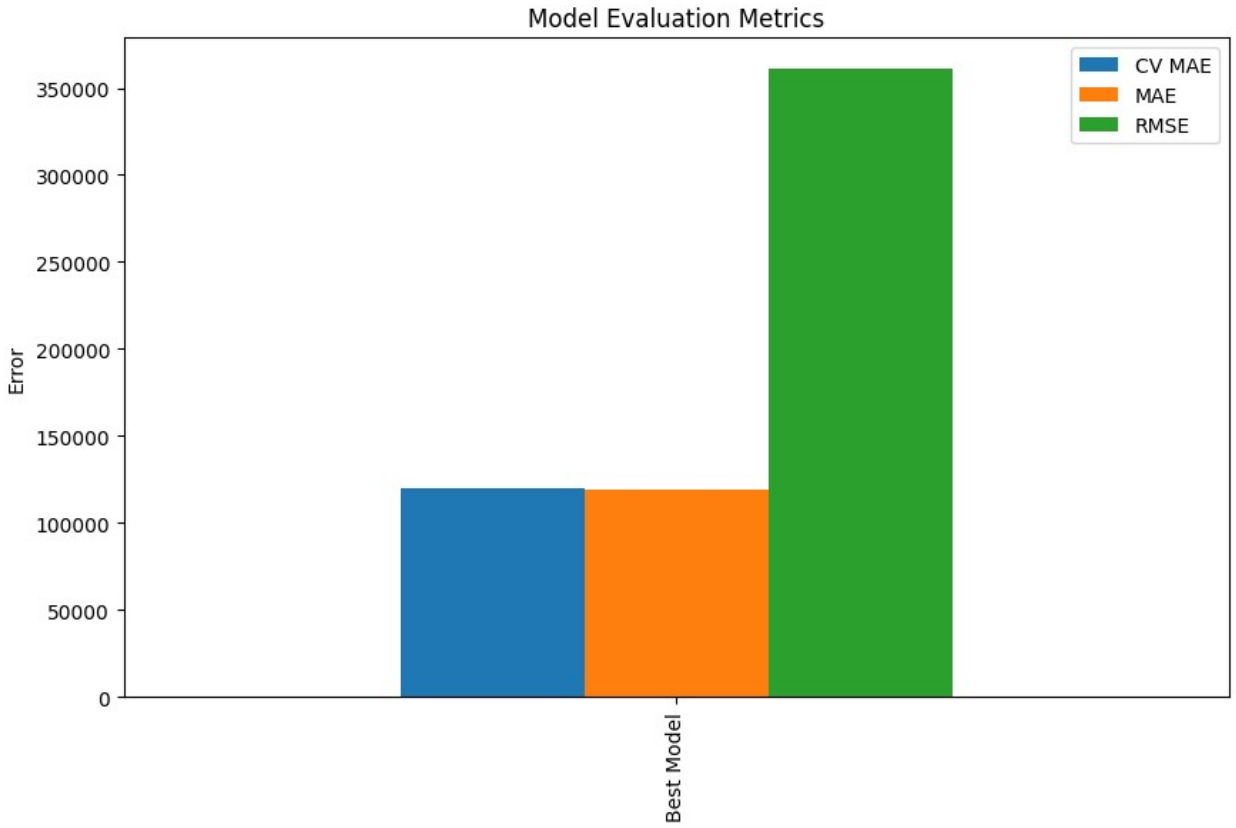
```
    ('model', RandomForestRegressor(random_state=42))
])

# Split data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

# Hyperparameter tuning with RandomizedSearchCV
param_dist = {
    'model__n_estimators': randint(100, 300),
    'model__max_depth': [None, 10, 20, 30],
    'model__min_samples_split': randint(2, 10),
    'model__min_samples_leaf': randint(1, 4)
}

random_search = RandomizedSearchCV(model_pipeline,
param_distributions=param_dist, n_iter=50, cv=5,
scoring='neg_mean_absolute_error', n_jobs=-1, random_state=42)
random_search.fit(X_train, y_train)
```

```
RandomizedSearchCV(cv=5,
                   estimator=Pipeline(steps=[('preprocessor',

ColumnTransformer(transformers=[('num',

StandardScaler(),

Index(['km_driven', 'age'], dtype='object')),

('cat',

OneHotEncoder(handle_unknown='ignore'),

Index(['name', 'fuel', 'seller_type', 'transmission', 'owner'],
dtype='object'))])),
                                              ('model',

RandomForestRegressor(random_state=42))]),
                   n_iter=50...
                                          'model__min_samples_leaf':
<scipy.stats._distn_infrastructure.rv_discrete_frozen object at
0x7b39a9c56020>,
                                          'model__min_samples_split':
<scipy.stats._distn_infrastructure.rv_discrete_frozen object at
0x7b39ae03e3b0>,
                                          'model__n_estimators':
<scipy.stats._distn_infrastructure.rv_discrete_frozen object at
0x7b39a9c56110>},
                   random_state=42, scoring='neg_mean_absolute_error')
```

```
# Evaluate the best model
best_model = random_search.best_estimator_
y_pred = best_model.predict(X_test)

mae = mean_absolute_error(y_test, y_pred)
rmse = np.sqrt(mean_squared_error(y_test, y_pred))

# Cross-validation
cv_scores = cross_val_score(best_model, X, y, cv=5,
scoring='neg_mean_absolute_error')
cv_mae = -np.mean(cv_scores)

results = {
    'Best Model': {'MAE': mae, 'RMSE': rmse, 'CV MAE': cv_mae}
}

# Display results
results_df = pd.DataFrame(results).T
print(results_df)
```

```
                    CV MAE            MAE           RMSE
Best Model  119728.354657  118913.741426  360738.940288
```

```
# Plot results
results_df.plot(kind='bar', figsize=(10, 6))
plt.ylabel('Error')
plt.title('Model Evaluation Metrics')
plt.show()
```


Model Evaluation Metrics
CV MAE
MAE
RMSE
Error
350000
300000
250000
200000
150000
100000
50000
0
Best Model