In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [3]:
```
from sklearn.datasets import fetch_openml
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_s
```

In [5]:
```
sns.set(style="whitegrid")
```

In [7]:
```
boston = fetch_openml(name='boston', version=1, as_frame=True)
df = boston.frame

df.head()
```

Out[7]:

| | CRIM | ZN | INDUS | CHAS | NOX | RM | AGE | DIS | RAD | TAX | PTRATIO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0.00632 | 18.0 | 2.31 | 0 | 0.538 | 6.575 | 65.2 | 4.0900 | 1 | 296.0 | 15.3 | 39 |
| **1** | 0.02731 | 0.0 | 7.07 | 0 | 0.469 | 6.421 | 78.9 | 4.9671 | 2 | 242.0 | 17.8 | 39 |
| **2** | 0.02729 | 0.0 | 7.07 | 0 | 0.469 | 7.185 | 61.1 | 4.9671 | 2 | 242.0 | 17.8 | 39 |
| **3** | 0.03237 | 0.0 | 2.18 | 0 | 0.458 | 6.998 | 45.8 | 6.0622 | 3 | 222.0 | 18.7 | 39 |
| **4** | 0.06905 | 0.0 | 2.18 | 0 | 0.458 | 7.147 | 54.2 | 6.0622 | 3 | 222.0 | 18.7 | 39 |

In [9]:
```
df.shape
df.info()
df.describe()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 14 columns):
 #   Column   Non-Null Count  Dtype   
---  ------   --------------  -----   
 0   CRIM     506 non-null    float64 
 1   ZN       506 non-null    float64 
 2   INDUS    506 non-null    float64 
 3   CHAS     506 non-null    category
 4   NOX      506 non-null    float64 
 5   RM       506 non-null    float64 
 6   AGE      506 non-null    float64 
 7   DIS      506 non-null    float64 
 8   RAD      506 non-null    category
 9   TAX      506 non-null    float64 
 10  PTRATIO  506 non-null    float64 
 11  B        506 non-null    float64 
 12  LSTAT    506 non-null    float64 
 13  MEDV     506 non-null    float64 
dtypes: category(2), float64(12)
memory usage: 49.0 KB
```

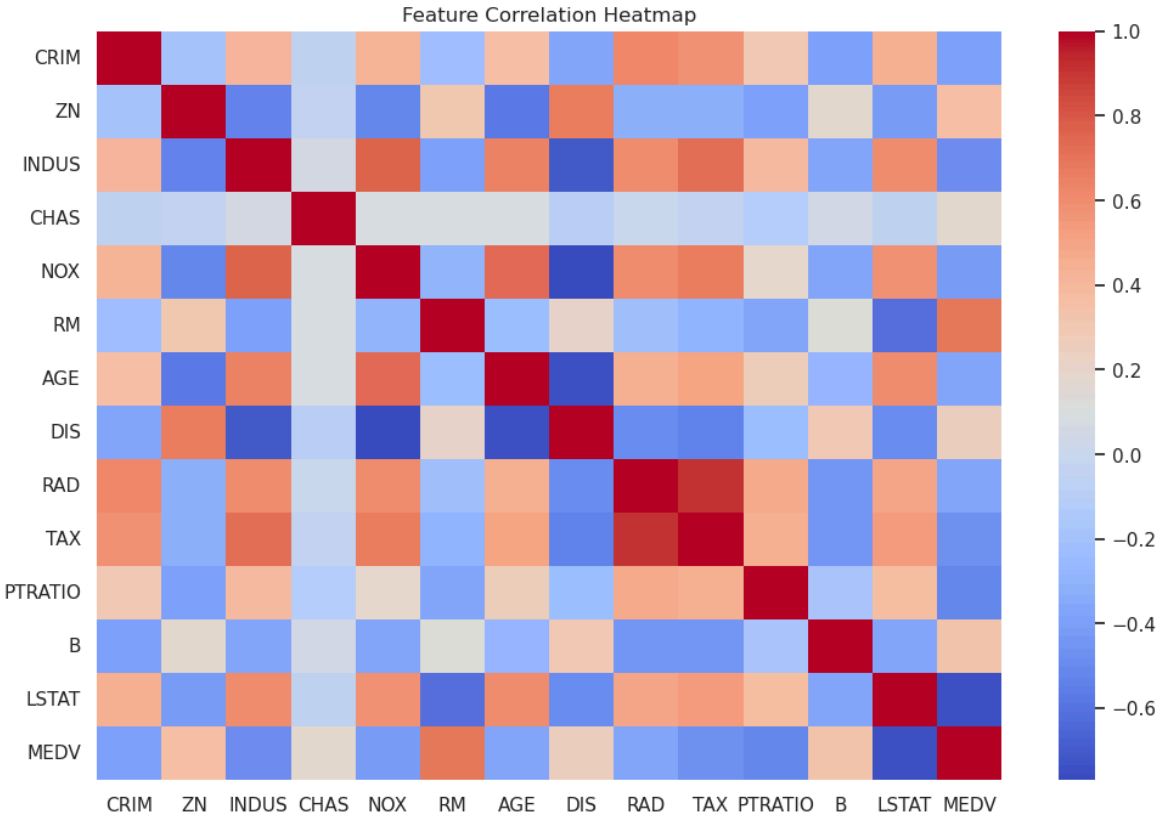
Out[9]:

| | CRIM | ZN | INDUS | NOX | RM | AGE | |
|---|---|---|---|---|---|---|---|
| **count** | 506.000000 | 506.000000 | 506.000000 | 506.000000 | 506.000000 | 506.000000 | 506.( |
| **mean** | 3.613524 | 11.363636 | 11.136779 | 0.554695 | 6.284634 | 68.574901 | 3.7 |
| **std** | 8.601545 | 23.322453 | 6.860353 | 0.115878 | 0.702617 | 28.148861 | 2.1 |
| **min** | 0.006320 | 0.000000 | 0.460000 | 0.385000 | 3.561000 | 2.900000 | 1.1 |
| **25%** | 0.082045 | 0.000000 | 5.190000 | 0.449000 | 5.885500 | 45.025000 | 2.1 |
| **50%** | 0.256510 | 0.000000 | 9.690000 | 0.538000 | 6.208500 | 77.500000 | 3.2 |
| **75%** | 3.677083 | 12.500000 | 18.100000 | 0.624000 | 6.623500 | 94.075000 | 5.1 |
| **max** | 88.976200 | 100.000000 | 27.740000 | 0.871000 | 8.780000 | 100.000000 | 12.1 |

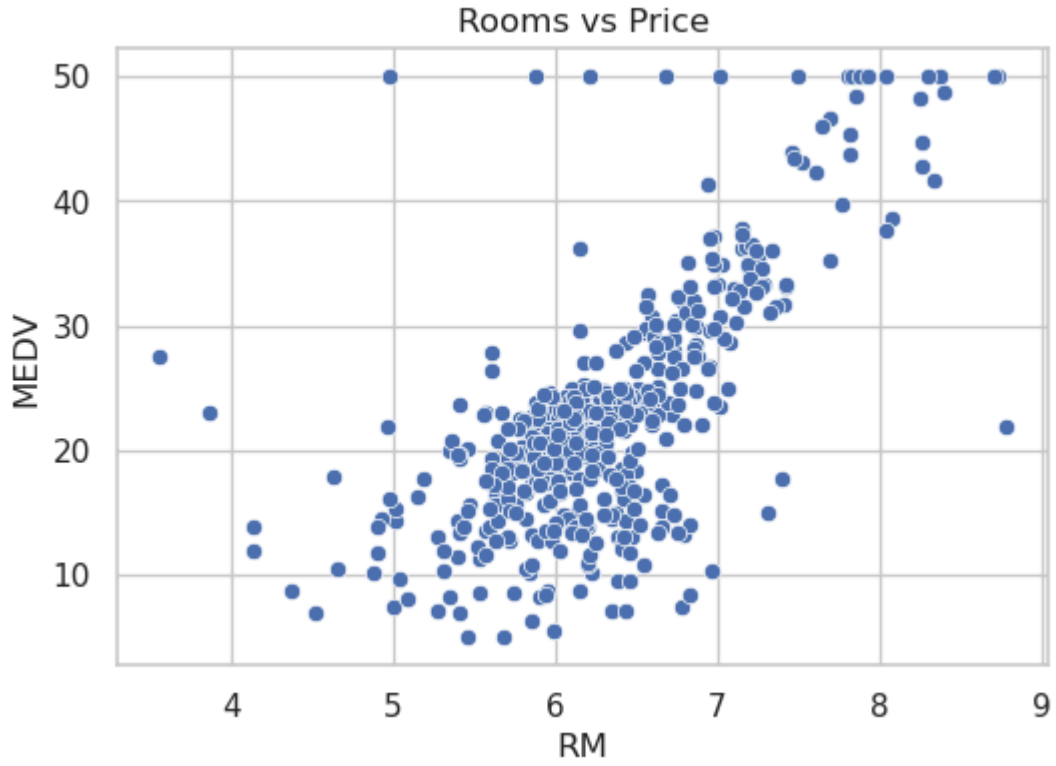
In [11]:
```
df.isnull().sum()
```

Out[11]:
```
CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
MEDV       0
dtype: int64
```

In [13]:
```
plt.figure(figsize=(12,8))
sns.heatmap(df.corr(), annot=False, cmap='coolwarm')
plt.title("Feature Correlation Heatmap")
plt.show()
```




In [15]:
```
plt.figure(figsize=(6,4))
sns.scatterplot(x=df['RM'], y=df['MEDV'])
plt.title("Rooms vs Price")
plt.show()
```




In [17]:
```
X = df.drop('MEDV', axis=1)  # independent variables
y = df['MEDV']               # target variable
```

In [19]:
```
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42
```

```
)

print("Training samples:", X_train.shape)
print("Testing samples:", X_test.shape)
```

```
Training samples: (404, 13)
Testing samples: (102, 13)
```

In [21]:
```
model = LinearRegression()
model.fit(X_train, y_train)
```

Out[21]:
```
LinearRegression()
```

In [23]:
```
coeff_df = pd.DataFrame(model.coef_, X.columns, columns=['Coefficient'])
coeff_df
```

Out[23]:

| | Coefficient |
|---|---|
| **CRIM** | -0.113056 |
| **ZN** | 0.030110 |
| **INDUS** | 0.040381 |
| **CHAS** | 2.784438 |
| **NOX** | -17.202633 |
| **RM** | 4.438835 |
| **AGE** | -0.006296 |
| **DIS** | -1.447865 |
| **RAD** | 0.262430 |
| **TAX** | -0.010647 |
| **PTRATIO** | -0.915456 |
| **B** | 0.012351 |
| **LSTAT** | -0.508571 |

In [27]:
```
X.dtypes
```

Out[27]:
```
CRIM        float64
ZN          float64
INDUS       float64
CHAS       category
NOX         float64
RM          float64
AGE         float64
DIS         float64
RAD        category
TAX         float64
PTRATIO     float64
B           float64
LSTAT       float64
dtype: object
```

In [29]:
```
X = X.apply(pd.to_numeric)
y = pd.to_numeric(y)
```

In [31]:
```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42
)
```

In [33]:
```
from sklearn.linear_model import LinearRegression

model = LinearRegression()
model.fit(X_train, y_train)
```

Out[33]:
```
LinearRegression
LinearRegression()
```

In [35]:
```
y_pred = model.predict(X_test)
```

In [37]:
```
from sklearn.metrics import mean_squared_error, r2_score
import numpy as np

print("RMSE:", np.sqrt(mean_squared_error(y_test, y_pred)))
print("R2 Score:", r2_score(y_test, y_pred))
```

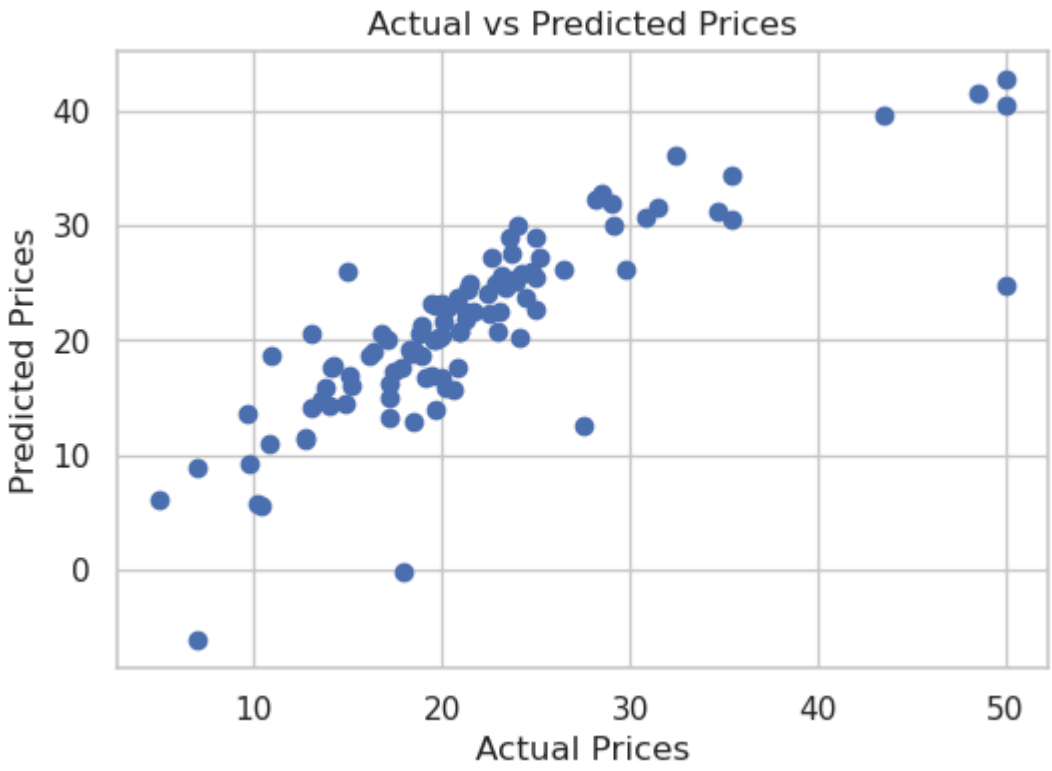
```
RMSE: 4.928602182665346
R2 Score: 0.6687594935356307
```

In [39]:
```
mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
rmse = np.sqrt(mse)
r2 = r2_score(y_test, y_pred)

print("Mean Absolute Error:", mae)
print("Mean Squared Error:", mse)
print("Root Mean Squared Error:", rmse)
print("R² Score:", r2)
```

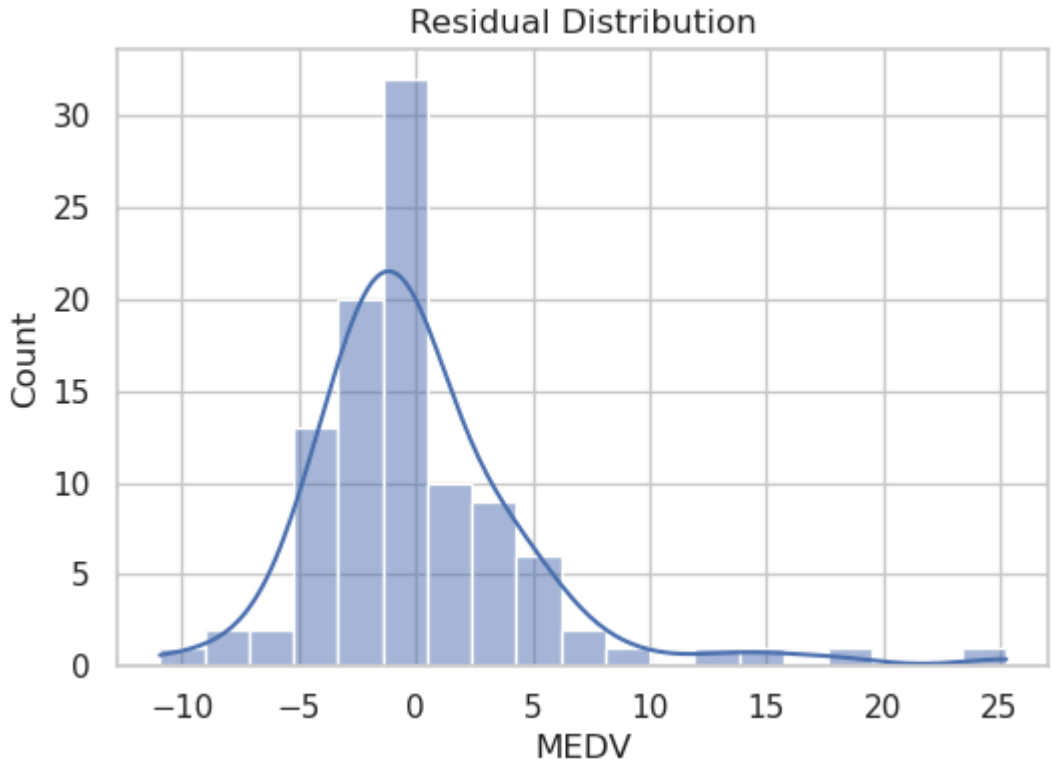
```
Mean Absolute Error: 3.189091965887852
Mean Squared Error: 24.291119474973613
Root Mean Squared Error: 4.928602182665346
R² Score: 0.6687594935356307
```

In [41]:
```
plt.figure(figsize=(6,4))
plt.scatter(y_test, y_pred)
plt.xlabel("Actual Prices")
plt.ylabel("Predicted Prices")
plt.title("Actual vs Predicted Prices")
plt.show()
```




In [43]:
```
residuals = y_test - y_pred

plt.figure(figsize=(6,4))
sns.histplot(residuals, kde=True)
plt.title("Residual Distribution")
plt.show()
```




In [ ]: