In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```
df = pd.read_csv('Boston.csv')
```

In [3]:

```
df.head()
```

Out[3]:

	Unnamed: 0	crim	zn	indus	chas	nox	rm	age	dis	rad	tax	ptratio	bl
0	1	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296	15.3	396
1	2	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	396
2	3	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	392
3	4	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	394
4	5	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7	396

In [4]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 15 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   Unnamed: 0  506 non-null    int64  
 1   crim        506 non-null    float64
 2   zn          506 non-null    float64
 3   indus       506 non-null    float64
 4   chas        506 non-null    int64  
 5   nox         506 non-null    float64
 6   rm          506 non-null    float64
 7   age         506 non-null    float64
 8   dis         506 non-null    float64
 9   rad         506 non-null    int64  
 10  tax         506 non-null    int64  
 11  ptratio     506 non-null    float64
 12  black       506 non-null    float64
 13  lstat       506 non-null    float64
 14  medv        506 non-null    float64
dtypes: float64(11), int64(4)
memory usage: 59.4 KB
```

In [5]:

```
df.shape
```

Out[5]:

```
(506, 15)
```

In [6]:

```
df.describe()
```

Out[6]:

	Unnamed: 0	crim	zn	indus	chas	nox	rm
count	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000
mean	253.500000	3.613524	11.363636	11.136779	0.069170	0.554695	6.284634
std	146.213884	8.601545	23.322453	6.860353	0.253994	0.115878	0.702617
min	1.000000	0.006320	0.000000	0.460000	0.000000	0.385000	3.561000
25%	127.250000	0.082045	0.000000	5.190000	0.000000	0.449000	5.885500
50%	253.500000	0.256510	0.000000	9.690000	0.000000	0.538000	6.208500
75%	379.750000	3.677083	12.500000	18.100000	0.000000	0.624000	6.623500
max	506.000000	88.976200	100.000000	27.740000	1.000000	0.871000	8.780000

In [7]:

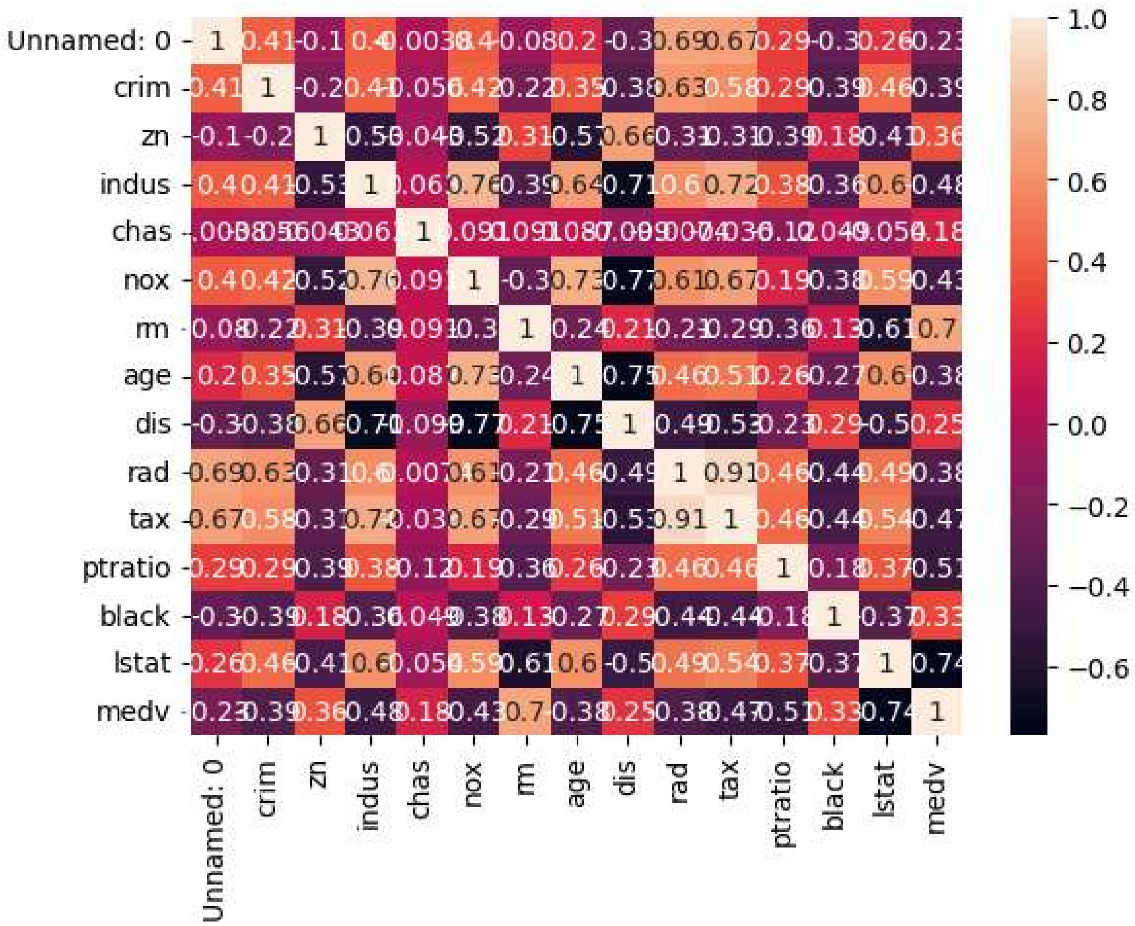
```
df.isnull().sum()
```

Out[7]:

```
Unnamed: 0    0
crim          0
zn            0
indus         0
chas          0
nox           0
rm            0
age           0
dis           0
rad           0
tax           0
ptratio       0
black         0
lstat         0
medv          0
dtype: int64
```

In [10]:

```
# Display correlation matrix
sns.heatmap(df.corr(),annot=True)
plt.show()
```



In [11]:
```
X = df[['ptratio','lstat']]
Y = df['medv']
```

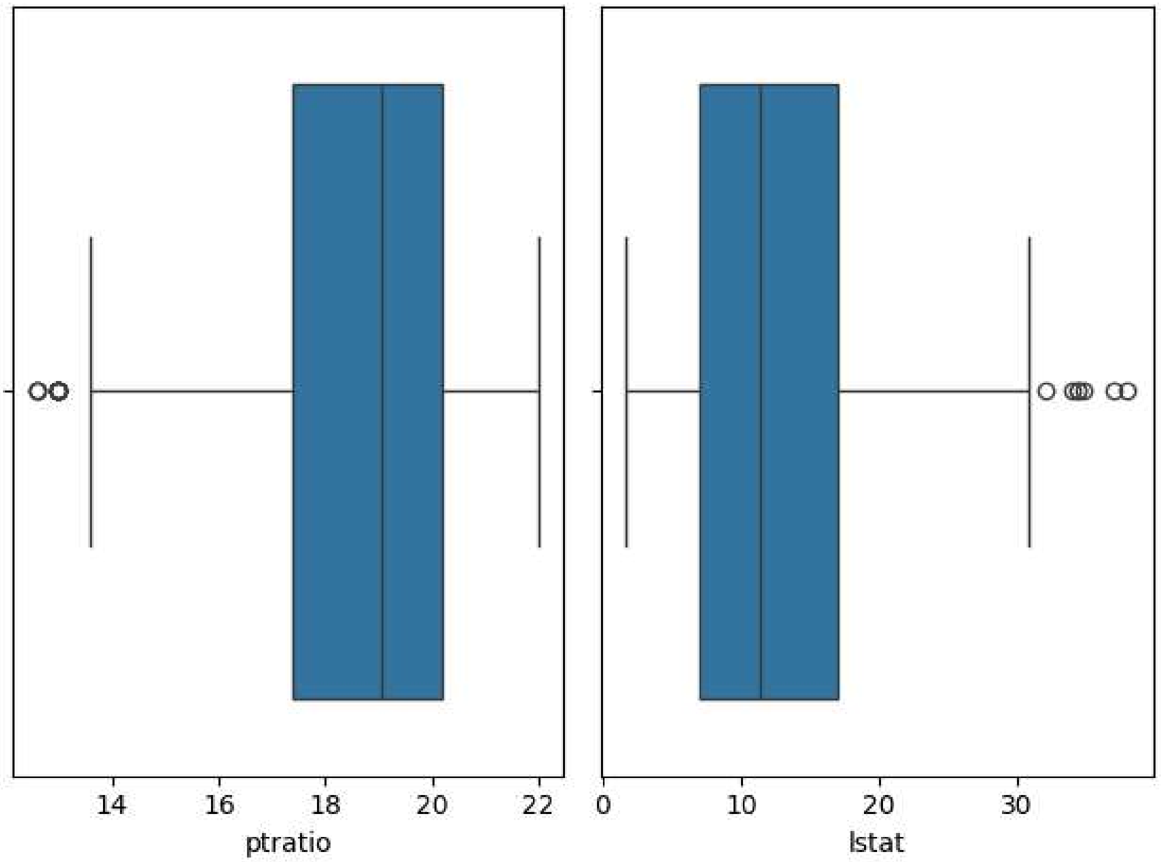
In [13]:
```
def BuildModel(X, Y):
# 1. divide the dataset into training and testing 80%train 20%testing
# 2. Choose the model (linear regression)
# 3. Train the model using training data
# 4. Test the model using testing data
# 5. Improve the performance of the model
# Training and testing data
    from sklearn.model_selection import train_test_split
# Assign test data size 20%
    xtrain, xtest, ytrain, ytest =train_test_split(X,Y,test_size= 0.20, random_stat
# Model selection and training
    from sklearn.linear_model import LinearRegression
    model = LinearRegression()
    model = model.fit(xtrain,ytrain) #Training
#Testing the model & show its accuracy / Performance
    ypred = model.predict(xtest)
    from sklearn.metrics import mean_absolute_error
    print('MAE:',mean_absolute_error(ytest,ypred))
    print("Model Score:",model.score(xtest,ytest))
```

In [14]:
```
BuildModel(X,Y)
```

```
MAE: 5.136709198623111
Model Score: 0.36774580178654837
```

In [18]:
```
# Checking model score after removing outliers
fig, axes = plt.subplots(1,2)
sns.boxplot(data = df, x ='ptratio', ax=axes[0])
sns.boxplot(data = df, x ='lstat', ax=axes[1])
```

```
fig.tight_layout()
plt.show()
```



In [20]:

```
def RemoveOutlier(df,var):
    Q1 = df[var].quantile(0.25)
    Q3 = df[var].quantile(0.75)
    IQR = Q3 - Q1
    high, low = Q3+1.5*IQR, Q1-1.5*IQR
    print("Highest allowed in variable:", var, high)
    print("lowest allowed in variable:", var, low)
    count = df[(df[var] > high) | (df[var] < low)][var].count()
    print('Total outliers in:',var,':',count)
    df = df[((df[var] >= low) & (df[var] <= high))]
    return df
```

In [22]:

```
df = RemoveOutlier(df, 'ptratio')
df = RemoveOutlier(df, 'lstat')
```

```
Highest allowed in variable: ptratio 24.4
lowest allowed in variable: ptratio 13.199999999999998
Total outliers in: ptratio : 15
Highest allowed in variable: lstat 32.09250000000001
lowest allowed in variable: lstat -7.847500000000005
Total outliers in: lstat : 6
```

In [23]:

```
# Choosing input and output variables from correlation matrix
X = df[['ptratio','lstat']]
Y = df['medv']
BuildModel(X, Y)
```

```
MAE: 4.529788999143725
Model Score: 0.5362875680057495
```

In [24]:

```
# after feature engineering selecting 3 variables
X = df[['rm','lstat', 'ptratio']]
```

```
Y = df['medv']
BuildModel(X, Y)
```

```
MAE: 4.030709795767343
Model Score: 0.5925717947605275
```