TERRO'S REAL ESTATE AGENCY

BUSINESS ANALYSIS REPORT

TADIMARRI MAHAMMAD AQIB

INDEX

Real estate data analysis : Exploratory data analysis, Linear Regression

1 .Problem Statement (Situation):

Terro's real-estate is an agency that estimates the pricing of houses in a certain locality. The pricing is concluded based on different features / factors of a property. This also helps them in identifying the business value of a property. To do this activity the company employs an "Auditor", who studies various geographic features of a property like pollution level (NOX), crime rate, education facilities (pupil to teacher ratio), connectivity (distance from highway), etc. This helps in determining the price of a property.

2 .Data Dictionary:

Attribute Description

- **CRIME RATE** : per capita crime rate by town
- **INDUSTRY** : proportion of non-retail business acres per town (in percentage terms)
- **NOX** : nitric oxides concentration (parts per 10 million)
- **AVG_ROOM** : average number of rooms per house
- **AGE** : proportion of houses built prior to 1940 (in percentage terms)
- **DISTANCE** : distance from highway (in miles)
- **TAX** : full-value property-tax rate per $10,000
- **PTRATIO** : pupil-teacher ratio by town
- **LSTAT** : % lower status of the population
- **AVG_PRICE** : Average value of houses in $1000's

3 .Objective (Task):

Your job, as an auditor, is to analyse the magnitude of each variable to which it can affect the price of a house in a particular locality.

4 .Questions:

1) Generate the summary statistics for each variable in the table. (Use Data analysis tool pack). Write down your observation.

The summary statistics tells us various measures i.e., mean, median, standard deviation, skewness etc. that are calculated based on the data points present in the variable. It can be helped to understand how the data points are distributed.

CRIME RATE

The Crime rate variable contains data whose mean is 4.87 and median is 4.82 which is almost similar so we can assume that the data points do not contain any outliers and the most frequent data point is 3.43 as shown in mode. The above measures tell about the measures of central tendency and now lets see about the measures of dispersion which tell how the values as dispersed from the centre. The Dispersion measures are Standard Deviation, Range, Variance and their values are 2.92, 9.95 and 8.53 respectively.

CRIME_RATE	
Mean	4.871976285
Standard Error	0.129860152
Median	4.82
Mode	3.43
Standard Deviation	2.921131892
Sample Variance	8.533011532
Kurtosis	-1.189122464
Skewness	0.021728079
Range	9.95
Minimum	0.04
Maximum	9.99
Sum	2465.22
Count	506

There are two measures which tell us about the symmetry of the data points when plotted in a graph those are called measures of symmetry, they are Kurtosis and Skewness whose values are -1.189 and 0.021 respectively. The Kurtosis tells us the frequency distribution of values in the graph, if there is a value with large frequency compared to other values it is depicted with sharp peak and it is known as Leptokurtic and outliers are highly frequent in such dataset. If the dataset has infrequent outliers and the distribution is thin tailed then it is called Platykurtic. If the distribution is medium tailed and outliers are neither highly frequent nor highly infrequent then it is Mesokurtic.

The kurtosis is in negative so it is Platykurtic. Skewness tells us the symmetry of the distribution is it to left or right it can be zero also. Since crime rate skewness is near to zero so it can be said zero skewed or approximately symmetric. Descriptive Statistics also tells us the Maximum, Minimum, Sum and Count of the dataset.

AGE	
Mean	68.57490119
Standard Error	1.251369525
Median	77.5
Mode	100
Standard Deviation	28.14886141
Sample Variance	792.3583985
Kurtosis	-0.967715594
Skewness	-0.59896264
Range	97.1
Minimum	2.9
Maximum	100
Sum	34698.9
Count	506

AGE

The Age Datasets measure of central tendency i.e., Mean is 68.57, Median is 77.5 and Mode is 100. We can infer that mean is less than median so there is a chance of outliers being present. The mid value in the dataset is 77.5, The data value with most frequency is 100.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 97.1, 28.15, and 792.358 respectively. Maximum is 100 and Minimum is 2.9 so the difference between Max and Min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

The Measures of Symmetry i.e., Skewness and Kurtosis are -0.59 and -0.96 respectively. Since skewness is between -0.5 and -1 so its moderately skewed and kurtosis is less than 3 so its Platykurtic. The Sum and count of the Age dataset are 34698.9 and 506 respectively.

INDUS

The INDUS Datasets measure of central tendency i.e., Mean is 11.136, Median is 9.69 and Mode is 18.1. We can infer that mean is higher than median so there is a chance of outliers being present. The mid value in the dataset is 9.69. The data value with most frequency is 18.1.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 27.28, 6.86, and 47.06 respectively. Maximum is 27.74 and Minimum is 0.46 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

INDUS	
Mean	11.13677866
Standard Error	0.304979888
Median	9.69
Mode	18.1
Standard Deviation	6.860352941
Sample Variance	47.06444247
Kurtosis	-1.233539601
Skewness	0.295021568
Range	27.28
Minimum	0.46
Maximum	27.74
Sum	5635.21
Count	506

The Measures of Symmetry i.e., Skewness and Kurtosis are 0.295 and -1.233 respectively. Since skewness is between -0.5 and 0.5 so it's approximately symmetric and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the INDUS dataset are 5635.21 and 506 respectively.

NOX	
Mean	0.554695059
Standard Error	0.005151391
Median	0.538
Mode	0.538
Standard Deviation	0.115877676
Sample Variance	0.013427636
Kurtosis	-0.064667133
Skewness	0.729307923
Range	0.486
Minimum	0.385
Maximum	0.871
Sum	280.6757
Count	506

NOX

The NOX Datasets measure of central tendency i.e., Mean is 0.55, Median is 0.538 and Mode is 0.538. We can infer that mean is almost same as median so there is a less chance of outliers being present. The mid value in the dataset is 0.538. The data value with most frequency is 0.538. Median, Mode and Mean are almost same so the data form a symmetric frequency distribution.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 0.486, 0.116, and 0.013 respectively. Maximum is 0.871 and Minimum is 0.385 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

The Measures of Symmetry i.e., Skewness and Kurtosis are 0.729 and -0.065 respectively. Since skewness is between 0.5 and 1 so it's moderately skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the NOX dataset are 280.68 and 506 respectively.

DISTANCE

The Distance Datasets measure of central tendency i.e. Mean is 9.549, Median is 5 and Mode is 24. We can infer that mean is higher than median so there is a chance of outliers being present. The mid value in the dataset is 5 and most of the data points lie near median. The data value with most frequency is 24.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 23, 8.707 and 75.816 respectively. Maximum is 24 and Minimum is 1 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

DISTANCE	
Mean	9.549407115
Standard Error	0.387084894
Median	5
Mode	24
Standard Deviation	8.707259384
Sample Variance	75.81636598
Kurtosis	-0.867231994
Skewness	1.004814648
Range	23
Minimum	1
Maximum	24
Sum	4832
Count	506

The Measures of Symmetry i.e., Skewness and Kurtosis are 1.005 and -0.867 respectively. Since skewness is above 1 so it's highly skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the Distance dataset are 4832 and 506 respectively.

TAX	
Mean	408.2371542
Standard Error	7.492388692
Median	330
Mode	666
Standard Deviation	168.5371161
Sample Variance	28404.75949
Kurtosis	-1.142407992
Skewness	0.669955942
Range	524
Minimum	187
Maximum	711
Sum	206568
Count	506

TAX

The TAX Datasets measure of central tendency i.e., Mean is 408.237, Median is 330 and Mode is 666. We can infer that mean is higher than median so there is a chance of outliers being present. The mid value in the dataset is 330 and most of the data points lie near median. The data value with most frequency is 666.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 524, 168.537 and 28404.76 respectively. Maximum is 711 and Minimum is 187 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

The Measures of Symmetry i.e., Skewness and Kurtosis are 0.6699 and -1.142 respectively. Since skewness is between 0.5 and 1 so it's moderately right skewed which is also known as Positively Skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the TAX dataset are 206568 and 506 respectively.

PTRATIO

The PTRATIO Datasets measure of central tendency i.e., Mean is 18.45, Median is 19.05 and Mode is 20.2. We can infer that mean is only slightly less than median so there is a less chance of outliers being present. The mid value in the dataset is 19.05 and most of the data points lie near median. The data value with most frequency is 20.2.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 9.4, 2.165 and 4.687 respectively. Maximum is 22 and Minimum is 12.6 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

PTRATIO	
Mean	18.4555336
Standard Error	0.096243568
Median	19.05
Mode	20.2
Standard Deviation	2.164945524
Sample Variance	4.686989121
Kurtosis	-0.285091383
Skewness	-0.802324927
Range	9.4
Minimum	12.6
Maximum	22
Sum	9338.5
Count	506

The Measures of Symmetry i.e., Skewness and Kurtosis are -0.802 and -0.285 respectively. Since skewness is between -0.5 and -1 so it's moderately skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the PTRATIO dataset are 9338.5 and 506 respectively.

AVG_ROOM	
Mean	6.284634387
Standard Error	0.031235142
Median	6.2085
Mode	5.713
Standard Deviation	0.702617143
Sample Variance	0.49367085
Kurtosis	1.891500366
Skewness	0.403612133
Range	5.219
Minimum	3.561
Maximum	8.78
Sum	3180.025
Count	506

AVG_ROOM

The Avg_Room Datasets measure of central tendency i.e., Mean is 6.284, Median is 6.208 and Mode is 5.713. We can infer that mean is almost same as median so there is a less chance of outliers being present. The mid value in the dataset is 6.208 and most of the data points lie near median. The data value with most frequency is 5.713.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 5.219, 0.703 and 0.494 respectively. Maximum is 8.78 and Minimum is 3.561 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

The Measures of Symmetry i.e., Skewness and Kurtosis are 0.404 and 1.89 respectively. Since skewness is between 0.5 and 1 so it's moderately skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the Avg_Room dataset are 3180.025 and 506 respectively.

LSTAT

The LSTAT Datasets measure of central tendency i.e., Mean is 12.653, Median is 11.36 and Mode is 8.05. We can infer that mean is slightly greater than median so there is a less chance of outliers being present. The mid value in the dataset is 11.36 and most of the data points lie near median. The data value with most frequency is 8.05.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 36.24, 7.141 and 50.995 respectively. Maximum is 37.97 and Minimum is 1.73 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

LSTAT	
Mean	12.65306324
Standard Error	0.317458906
Median	11.36
Mode	8.05
Standard Deviation	7.141061511
Sample Variance	50.99475951
Kurtosis	0.493239517
Skewness	0.906460094
Range	36.24
Minimum	1.73
Maximum	37.97
Sum	6402.45
Count	506

The Measures of Symmetry i.e., Skewness and Kurtosis are 0.906 and 0.493 respectively. Since skewness is between 0.5 and 1 so it's moderately skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the LSTAT dataset are 6402.45 and 506 respectively.

AVG_PRICE	
Mean	22.53280632
Standard Error	0.408861147
Median	21.2
Mode	50
Standard Deviation	9.197104087
Sample Variance	84.58672359
Kurtosis	1.495196944
Skewness	1.108098408
Range	45
Minimum	5
Maximum	50
Sum	11401.6
Count	506

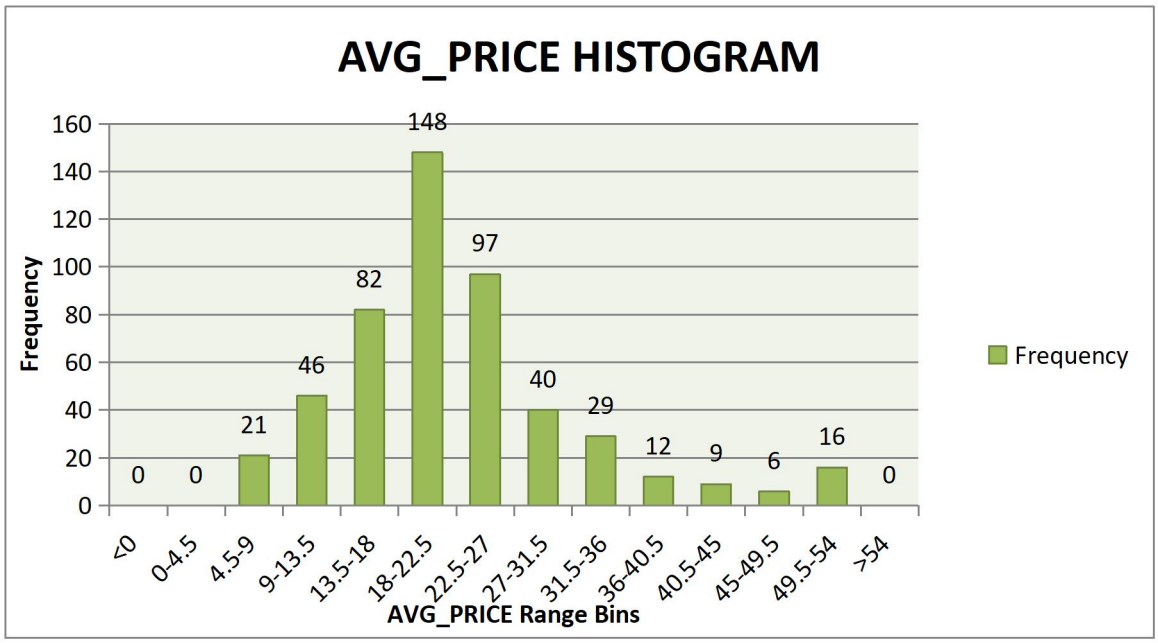
AVG_PRICE

The Avg_Price Datasets measure of central tendency i.e., Mean is 22.53, Median is 21.2 and Mode is 50. We can infer that mean is slightly greater than median so there is a less chance of outliers being present. The mid value in the dataset is 21.2 and most of the data points lie near median. The data value with most frequency is 50.

The Measures of Dispersion i.e., Range, Standard Deviation, Variance are 45, 9.197 and 84.586 respectively. Maximum is 50 and Minimum is 5 so the difference between max and min is the range. Variance is the sum of squares of each data points distance from the mean by total number of variables. Standard deviation is the root of variance.

The Measures of Symmetry i.e., Skewness and Kurtosis are 1.108 and 1.495 respectively. Since skewness is above so it's highly skewed and kurtosis is less than 3 so it's Platykurtic. The Sum and count of the AVG_PRICE dataset are 11401.6 and 506 respectively.

2) Plot a histogram of the Avg_Price variable. What do you infer?



The Observations we can infer from the above Histogram is the frequency of the Avg_Price. It depicts the data values present in the Avg_Price variable which are dispersed from 5K USD to 45K USD. The Data values are present in different range bins and the range with more number of data points is 18K - 22.5K. The histogram depicts that there are no outliers present in the data points. The Avg_Price of the houses are mostly between 13.5K to 27K. Median and mean are also present in this range. The graph is slightly positively skewed because the symmetry is falling to the left. The Avg_Price is Leptokurtic as the graph shows a sharp peak in the graph.

3) Compute the covariance matrix. Share your observations.

The Covariance Matrix tells us about joint dispersion of two variables i.e., product of summation of distances of data values of both variables from their mean by total number of data values. We can check the covariance of any two variables from the matrix. The Covariance tells us the direction.

	CRIME_RATE	AGE	INDUS	NOX	DISTANCE	TAX	PTRATIO	AVG_ROOM	LSTAT	AVG_PRICE
CRIME_RATE	8.516									
AGE	0.563	790.792								
INDUS	-0.110	124.268	46.9714							
NOX	0.001	2.381	0.6059	0.013						
DISTANCE	-0.230	111.550	35.4797	0.616	75.667					
TAX	-8.229	2397.942	831.7133	13.021	1333.117	28348.624				
PTRATIO	0.068	15.905	5.6809	0.047	8.743	167.821	4.678			
AVG_ROOM	0.056	-4.743	-1.8842	-0.025	-1.281	-34.515	-0.540	0.493		
LSTAT	-0.883	120.838	29.5218	0.488	30.325	653.421	5.771	-3.074	50.894	
AVG_PRICE	1.162	-97.396	-30.4605	-0.455	-30.501	-724.820	-10.091	4.485	-48.352	84.420

The Matrix is symmetrical and the diagonal values are always the variance of the variable. In the matrix if the x and y values are both above average then the value will be +ve. If x and y are mostly on opposite sides of their averages then covariance is –ve.

We can see that the diagonal values are all the variances of the variables.

Covariance.s (array1, array2) == Variance.s (array)

There are both positive and negative values in the matrix .The Positive Values i.e., Avg_Price & Crime_Rate etc., which tells us that the positives are values whose x and y values are above their mean , whereas The Negatives i.e., Avg_Price & Age etc., have their x and y in opposite sides of their average. Since the matrix is symmetric so only lower triangle will be filled with values and the above values are the mirror image of the lower triangle.

4) Create a correlation matrix of all the variables (Use Data analysis tool pack).
a) Which are the top 3 positively correlated pairs and
b) Which are the top 3 negatively correlated pairs.

Using the Data analysis the correlation matrix was built. It is also similar to the covariance matrix. In covariance matrix we get to know the direction but in this we get to know magnitude. The value of the magnitude is always between -1 and 1. It is a dimension less variable. If the value of any two variables is +ve, that means the relationship is positive otherwise negative.

The correlation coefficient is +ve then that means with increase in x there is also increase in y. We can say x is directly proportional to y. If the coefficient is –ve that means with increase in x, y is gradually decreasing. It can be said x and y are inversely proportional. The value being close to 0 then it means there is no correlation between the pair, if value near +1 then the pair has positively linear relationship. If value is near -1 then the pair has negatively liner relationship.

	CRIME_RATE	AGE	INDUS	NOX	DISTANCE	TAX	PTRATIO	AVG_ROOM	LSTAT	AVG_PRICE
CRIME_RATE	1									
AGE	0.00686	1								
INDUS	-0.00551	0.64478	1							
NOX	0.00185	0.73147	0.76365	1						
DISTANCE	-0.00906	0.45602	0.59513	0.61144	1					
TAX	-0.01675	0.50646	0.72076	0.66802	0.91023	1				
PTRATIO	0.01080	0.26152	0.38325	0.18893	0.46474	0.46085	1			
AVG_ROOM	0.02740	-0.24026	-0.39168	-0.30219	-0.20985	-0.29205	-0.35550	1		
LSTAT	-0.04240	0.60234	0.60380	0.59088	0.48868	0.54399	0.37404	-0.61381	1	
AVG_PRICE	0.04334	-0.37695	-0.48373	-0.42732	-0.38163	-0.46854	-0.50779	0.69536	-0.73766	1

The correlation of a variable with itself is always 1. So, we get 1 in the diagonal as the pairs are in correlation with themselves. The absolute value of the correlation coefficient tells us how strong the relation is between the two variables i.e.,

r = 0 - 0.19 (Very Weak)
r = 0.2 - 0.39 (Weak)
r = 0.4 - 0.59 (Moderate)
r = 0.6 - 0.79 (Strong)
r = 0.8 - 1 (Very Strong)

The top three positively correlated pairs and the top three negatively correlated pairs from the above correlation matrix are as below.

Top 3 Positively Correlated	Top 3 Negatively Correlated
0.910228189	-0.737662726
0.763651447	-0.613808272
0.731470104	-0.507786686

5) Build an initial regression model with AVG_PRICE as 'y' (Dependent variable) and LSTAT variable as Independent Variable. Generate the residual plot.

a) What do you infer from the Regression Summary output in terms of Variance explained, coefficient value, Intercept, and the Residual plot?

b) Is LSTAT variable significant for the analysis based on your model?

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7377
R Square	0.5441
Adjusted R Square	0.5432
Standard Error	6.2158
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	23243.9	23243.9	601.6	5.08E-88
Residual	504	19472.4	38.6		
Total	505	42716.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	34.554	0.563	61.415	3.7E-236	33.448	35.659	33.448	35.659
LSTAT	-0.950	0.039	-24.528	5.1E-88	-1.026	-0.874	-1.026	-0.874

Regression Equation: *AVG_PRICE = 34.554 + (-0.950)*LSTAT*

a) Regression Summary tells us how well the linear regression model we built fits the data given. It contains different measures that help us in determining the acceptance of the model and also to compare between two or more models. The summary contains various variables such as Multiple R, R2, Adjusted R2, Coefficients, T-stat, P-value, Standard Error etc.

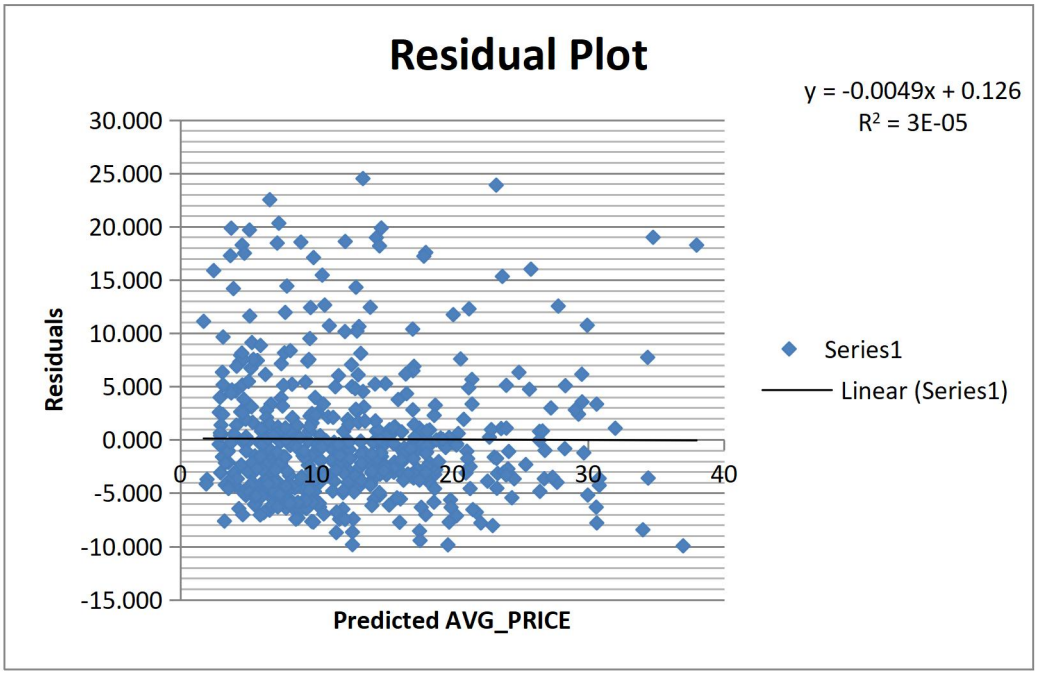
The inference of above summary can be explained in terms of variance, coefficient value, intercept, and residual plot. The summary contains a measure called Multiple R which is the correlation coefficient which tells us how strong the linear relationship is. The R Square is the coefficient of determination which tells us the proportion of variation of Y values around mean which are explained by X. The Adjusted R square adjusts for the number of terms in model and it's mostly instead of R square if more than one independent variable is present. The values of the measures that are generated by the regression model are 0.7377, 0.5441, and 0.5432 for Multiple R, R Square and Adjusted R Square respectively.

Regression Statistics	
Multiple R	0.737662726
R Square	0.544146298
Adjusted R Square	0.543241826

Coefficient values interpret the values by which the dependent variable is getting affected by a unit change in the respective independent variable. Since the model we built is linear regression so we have only two coefficient values one is Intercept whose value is 34.553 and other one is LSTAT coefficient i.e., X coefficient whose value is -0.95. The Coefficient values indicate us about the relation between Y and X. If coefficient is -ve then X and Y negatively related its otherwise if its +ve. The Intercept tells us Y value if the X is 0 or the X coefficient is 0, this value is the point where the line touches the y-axis in the graph.

	Coefficients
Intercept	34.55384088
LSTAT	-0.950049354

A residual plot is a scatter plot that displays the residuals on the vertical axis and the independent variable on the horizontal axis. Residual plots help us to determine whether a linear model is appropriate in modelling the given data. Since a residual is the "leftover" value after subtracting the expected value from the actual value and the expected value is obtained through a linear model such as a line of best fit, a residual plot shows how the data points deviate from the model.
If the residuals are randomly scattered around, it means that a linear model approximates the data points well without favouring certain inputs. In such a case, we conclude that a linear model is appropriate. If the residuals show a curved pattern, it indicates that a linear model captures the trend of some data points better than that of others. In such a case, we should consider using a model other than a linear model. Since the below residual plot is not showing any pattern we can conclude that the linear regression model we built is appropriate.



b) Yes, LSTAT variable is significant as per the model built since its p-value is less than 0.05. A p-value measures the probability of obtaining the observed results, assuming that the null hypothesis is true. The lower the p-value, the greater the statistical significance of the observed difference. A p-value of 0.05 or lower is generally considered statistically significant.

	P-value
Intercept	3.7431E-236
LSTAT	5.0811E-88

6) Build a new Regression model including LSTAT and AVG_ROOM together as Independent variables and AVG_PRICE as dependent variable.

a) Write the Regression equation. If a new house in this locality has 7 rooms (on an average) and has a value of 20 for L-STAT, then what will be the value of AVG_PRICE? How does it compare to the company quoting a value of 30000 USD for this locality? Is the company Overcharging/Undercharging?

b) Is the performance of this model better than the previous model you built in Question 5? Compare in terms of adjusted R-square and explain.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7991
R Square	0.6386
Adjusted R Square	0.6371
Standard Error	5.5403
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	27276.986	13638.493	444.331	7.01E-112
Residual	503	15439.309	30.694		
Total	505	42716.295			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.3583	3.1728	-0.4281	0.6688	-7.5919	4.8754	-7.5919	4.8754
AVG_ROOM	5.0948	0.4445	11.4627	3.47E-27	4.2216	5.9680	4.2216	5.9680
LSTAT	-0.6424	0.0437	-14.6887	6.67E-41	-0.7283	-0.5564	-0.7283	-0.5564

a) From the regression summary, the coefficient of the intercept gives us the alpha value, coefficient of avg_room is beta one and coefficient of LSTAT is beta two. We now substitute these coefficients and get the equation.

Regression Equation:	AVG_PRICE= (-1.358272812) + 5.094787984*AVG_ROOM + (-0.642358334)*LSTAT

The values of Avg_Room and LSTAT are given as 7 and 20 respectively, we now substitute in the equation.

$$AVG\_PRICE = (-1.358272812) + 5.094787984 * 7 + (-0.642358334) * 20$$

$$AVG\_PRICE = 21.458076396$$

We observe that the avg_price of the house in Boston as 21.45K but the company is quoting 30K. So the company is overcharging for the houses.

b) The Adjusted R square adjusts for the number of terms in model and it's mostly instead of R square if more than one independent variable is present. So, we use adjusted R square to compare this model and previous model as there is a difference in the independent variables used. The model with best adjusted R square has better performance. The previous model has the adjusted R square value of 54% and the current model has the adjusted R square of 63%. There is clear difference between the two models and the current regression model has better performance.

Current Model	
Adjusted R Square	0.637124

Previous Model	
Adjusted R Square	0.543242

7) Build another Regression model with all variables where AVG_PRICE alone be the Dependent Variable and all the other variables are independent. Interpret the output in terms of adjusted R square, coefficient and Intercept values. Explain the significance each independent variable with respect to AVG_PRICE.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.8330
R Square	0.6939
Adjusted R Square	0.6883
Standard Error	5.1348
Observations	506

ANOVA

	df	SS	MS	F	Significance F
Regression	9	29638.86	3293.21	124.90	1.9328E-121
Residual	496	13077.43	26.37		
Total	505	42716.30			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	29.2413	4.8171	6.0703	2.54E-09	19.7768	38.7058	19.7768	38.7058
CRIME_RATE	0.0487	0.0784	0.6213	0.5347	-0.1053	0.2028	-0.1053	0.2028
AGE	0.0328	0.0131	2.5020	0.0127	0.0070	0.0585	0.0070	0.0585
INDUS	0.1306	0.0631	2.0684	0.0391	0.0065	0.2546	0.0065	0.2546
NOX	-10.3212	3.8940	-2.6505	0.0083	-17.9720	-2.6703	-17.9720	-2.6703
DISTANCE	0.2611	0.0679	3.8426	0.0001	0.1276	0.3946	0.1276	0.3946
TAX	-0.0144	0.0039	-3.6877	0.0003	-0.0221	-0.0067	-0.0221	-0.0067
PTRATIO	-1.0743	0.1336	-8.0411	6.59E-15	-1.3368	-0.8118	-1.3368	-0.8118
AVG_ROOM	4.1254	0.4428	9.3175	3.89E-19	3.2555	4.9953	3.2555	4.9953
LSTAT	-0.6035	0.0531	-11.3691	8.91E-27	-0.7078	-0.4992	-0.7078	-0.4992

Regression Equation:	AVG_SALES = 29.24 + 0.0487*CRIME_RATE + 0.0328*AGE + 0.1305*INDUS + (-10.321)*NOX + 0.261*DISTANCE + (-0.0144)*TAX + (-1.0743)*PTRATIO + 4.125*AVG_ROOM + (-0.603)*LSTAT

The inference of above summary can be explained in terms of variance, coefficient value, intercept, and residual plot. The summary contains a measure called Multiple R which is the correlation coefficient which tells us how strong the linear relationship is. The R Square is the coefficient of determination which tells us the proportion of variation of Y values around mean which are explained by X.

Regression Statistics	
Multiple R	0.832978824
R Square	0.69385372
Adjusted R Square	0.688298647

The Adjusted R square adjusts for the number of terms in model and it's mostly instead of R square if more than one independent variable is present. The values of the measures that are generated by the regression model are 0.8329, 0.6938, and 0.6883 for Multiple R, R Square and Adjusted R Square respectively.

	Coefficients
Intercept	29.24131526
CRIME_RATE	0.048725141
AGE	0.032770689
INDUS	0.130551399
NOX	-10.3211828
DISTANCE	0.261093575
TAX	-0.01440119
PTRATIO	-1.074305348
AVG_ROOM	4.125409152
LSTAT	-0.603486589

Coefficient values interpret the values by which the dependent variable is getting affected by a unit change in the respective independent variable. Since the model we built is multi linear regression with more than one independent variable so we have more coefficient values, one is Intercept whose value is 29.241. The Intercept tells us Y value if the all X values are 0 or the X coefficients are 0, this value is the point where the line touches the y-axis in the graph. The Coefficient values indicate us about the relation between Y and X. The coefficient is -ve then X and Y negatively related it's otherwise its +ve. The variables which have positive relation with Avg_Price are Crime_Rate, Age, Indus, Distance and Avg_Room. The variables which are negatively affecting are NOX, Tax, PTRATIO and LSTAT.

The p-value for each independent variable tests the null hypothesis that the variable has no correlation with the dependent variable. If there is no correlation, there is no change in dependent variable with increase or decrease in independent variable. If the p-value for a variable is less than your significance level, your sample data provide enough evidence to reject the null hypothesis for the entire population. This variable is statistically significant and probably a worthwhile addition to your regression model. On the other hand, when a p value in regression is greater than the significance level, it indicates there is insufficient evidence in your sample to conclude that a correlation exists.

	P-value
Intercept	2.53978E-09
CRIME_RATE	0.534657201
AGE	0.012670437
INDUS	0.03912086
NOX	0.008293859
DISTANCE	0.000137546
TAX	0.000251247
PTRATIO	6.58642E-15
AVG_ROOM	3.89287E-19
LSTAT	8.91071E-27

Since all the independent variables except Crime_Rate variable have p-value less than 0.05 which is significance, we can consider adding them in the regression model and remove Crime_Rate variable to increase the model performance.

8) Pick out only the significant variables from the previous question. Make another instance of the Regression model using only the significant variables you just picked and answer the questions below:

a) Interpret the output of this model.

b) Compare the adjusted R-square value of this model with the model in the previous question, which model performs better according to the value of adjusted R-square?

c) Sort the values of the Coefficients in ascending order. What will happen to the average price if the value of NOX is more in a locality in this town?

d) Write the regression equation from this model.

a) The summary contains a measure called Multiple R which is the correlation coefficient which tells us how strong the linear relationship is. The R Square is the coefficient of determination which tells us the proportion of variation of Y values around mean which are explained by X.

The Adjusted R square adjusts for the number of terms in model and it's mostly instead of R square if more than one independent variable is present. The values of the measures that are generated by the regression model are 0.8328, 0.6936, and 0.6887 for Multiple R, R Square and Adjusted R Square respectively.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.8328
R Square	0.6936
Adjusted R Square	0.6887
Standard Error	5.1316
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	29628.681	3703.585	140.643	1.911E-122
Residual	497	13087.614	26.333		
Total	505	42716.295			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	29.428	4.805	6.125	1.8E-09	19.988	38.869	19.988	38.869
AGE	0.033	0.013	2.517	0.0122	0.007	0.059	0.007	0.059
INDUS	0.131	0.063	2.072	0.0388	0.007	0.255	0.007	0.255
NOX	-10.273	3.891	-2.640	0.0085	-17.917	-2.628	-17.917	-2.628
DISTANCE	0.262	0.068	3.851	0.0001	0.128	0.395	0.128	0.395
TAX	-0.014	0.004	-3.704	0.0002	-0.022	-0.007	-0.022	-0.007
PTRATIO	-1.072	0.133	-8.031	7.1E-15	-1.334	-0.809	-1.334	-0.809
AVG_ROOM	4.125	0.442	9.323	3.7E-19	3.256	4.995	3.256	4.995
LSTAT	-0.605	0.053	-11.422	5.4E-27	-0.709	-0.501	-0.709	-0.501

Coefficient values interpret the values by which the dependent variable is getting affected by a unit change in the respective independent variable. Since the model we built is multi linear regression with more than one independent variable so we have more coefficient values, one is Intercept whose value is 29.248. The Intercept tells us Y value if the all X values are 0 or the X coefficients are 0, this value is the point where the line touches the y-axis in the graph. The Coefficient values indicate us about the relation between Y and X. The coefficient is -ve then X and Y negatively related it's otherwise its +ve. The variables which have positive relation with Avg_Price are Crime_Rate, Age, Indus, Distance and Avg_Room. The variables which are negatively affecting are NOX, Tax, PTRATIO and LSTAT.

b) The Adjusted R square adjusts for the number of terms in model and it's mostly instead of R square if more than one independent variable is present. So, we use adjusted R square to compare this model and previous model as there is a difference in the independent

variables used. The model with best adjusted R square has better performance. The previous model has the adjusted R square value of 68.83% and the current model has the adjusted R square of 68.87%. There is slight difference between the two models and the current regression model has better performance.

Current Model	
Adjusted R Square	0.688683682

Previous Model	
Adjusted R Square	0.688299

c)

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
NOX	-10.27270508	3.890849222	-2.640221837	0.008545718	-17.9172457	-2.628164466	-17.9172457	-2.628164466
PTRATIO	-1.071702473	0.133453529	-8.030529271	7.08251E-15	-1.333905109	-0.809499836	-1.333905109	-0.809499836
LSTAT	-0.605159282	0.0529801	-11.42238841	5.41844E-27	-0.70925186	-0.501066704	-0.70925186	-0.501066704
TAX	-0.014452345	0.003901877	-3.703946406	0.000236072	-0.022118553	-0.006786137	-0.022118553	-0.006786137
AGE	0.03293496	0.013087055	2.516605952	0.012162875	0.007222187	0.058647734	0.007222187	0.058647734
INDUS	0.130710007	0.063077823	2.072202264	0.038761669	0.006777942	0.254642071	0.006777942	0.254642071
DISTANCE	0.261506423	0.067901841	3.851242024	0.000132887	0.128096375	0.394916471	0.128096375	0.394916471
AVG_ROOM	4.125468959	0.44248544	9.323400461	3.68969E-19	3.256096304	4.994841615	3.256096304	4.994841615
Intercept	29.42847349	4.804728624	6.124898157	1.84597E-09	19.98838959	38.8685574	19.98838959	38.8685574

The Coefficient values indicate us about the relation between Y and X. The coefficient is -ve then X and Y negatively related it's otherwise its +ve. The NOX variable and Avg_Price have a negative relation as we can observe from the above table. In other words, with a unit value increase in NOX variable the Avg_Price value is decreasing by 10.272.

d)

Regression Equation:	AVG_SALES = 29.428 + 0.0329*AGE + 0.1307*INDUS + (-10.2727)*NOX + 0.2615*DISTANCE + (-0.01445)*TAX + (-1.0717)*PTRAIO + 4.125*AVG_ROOM + (-0.605)*LSTAT

The Regression Equation above is generated after performing the regression analysis on the data. It gives us the success rate of 69%.