Problem:

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.

Objective:

To analyze the magnitude of each variable to which it can affect the price of a house in a particular locality.

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

CRIME_RATE		*AGE*		*INDUS*	
Mean	4.871976	Mean	68.5749	Mean	11.13678
Standard Error	0.12986	Standard Error	1.25137	Standard Error	0.30498
Median	4.82	Median	77.5	Median	9.69
Mode	3.43	Mode	100	Mode	18.1
Standard Deviation	2.921132	Standard Deviation	28.14886	Standard Deviation	6.860353
Sample Variance	8.533012	Sample Variance	792.3584	Sample Variance	47.06444
Kurtosis	-1.18912	Kurtosis	-0.96772	Kurtosis	-1.23354
Skewness	0.021728	Skewness	-0.59896	Skewness	0.295022
Range	9.95	Range	97.1	Range	27.28
Minimum	0.04	Minimum	2.9	Minimum	0.46
Maximum	9.99	Maximum	100	Maximum	27.74
Sum	2465.22	Sum	34698.9	Sum	5635.21
Count	506	Count	506	Count	506

NOX		*DISTANCE*		*TAX*	
Mean	0.554695	Mean	9.549407	Mean	408.2372
Standard Error	0.005151	Standard Error	0.387085	Standard Error	7.492389
Median	0.538	Median	5	Median	330
Mode	0.538	Mode	24	Mode	666
Standard Deviation	0.115878	Standard Deviation	8.707259	Standard Deviation	168.5371
Sample Variance	0.013428	Sample Variance	75.81637	Sample Variance	28404.76
Kurtosis	-0.06467	Kurtosis	-0.86723	Kurtosis	-1.14241
Skewness	0.729308	Skewness	1.004815	Skewness	0.669956
Range	0.486	Range	23	Range	524
Minimum	0.385	Minimum	1	Minimum	187
Maximum	0.871	Maximum	24	Maximum	711
Sum	280.6757	Sum	4832	Sum	206568
Count	506	Count	506	Count	506

PTRATIO		*AVG_ROOM*		*LSTAT*		*AVG_PRICE*	
Mean	18.45553	Mean	6.284634	Mean	12.65306	Mean	22.53281
Standard Error	0.096244	Standard Error	0.031235	Standard Error	0.317459	Standard Error	0.408861
Median	19.05	Median	6.2085	Median	11.36	Median	21.2
Mode	20.2	Mode	5.713	Mode	8.05	Mode	50
Standard Deviation	2.164946	Standard Deviation	0.702617	Standard Deviation	7.141062	Standard Deviation	9.197104
Sample Variance	4.686989	Sample Variance	0.493671	Sample Variance	50.99476	Sample Variance	84.58672
Kurtosis	-0.28509	Kurtosis	1.8915	Kurtosis	0.49324	Kurtosis	1.495197
Skewness	-0.80232	Skewness	0.403612	Skewness	0.90646	Skewness	1.108098
Range	9.4	Range	5.219	Range	36.24	Range	45
Minimum	12.6	Minimum	3.561	Minimum	1.73	Minimum	5
Maximum	22	Maximum	8.78	Maximum	37.97	Maximum	50
Sum	9338.5	Sum	3180.025	Sum	6402.45	Sum	11401.6
Count	506	Count	506	Count	506	Count	506

From descriptive statistics of the given dataset we can get few observations as:

The number of records given in the dataset are 506.

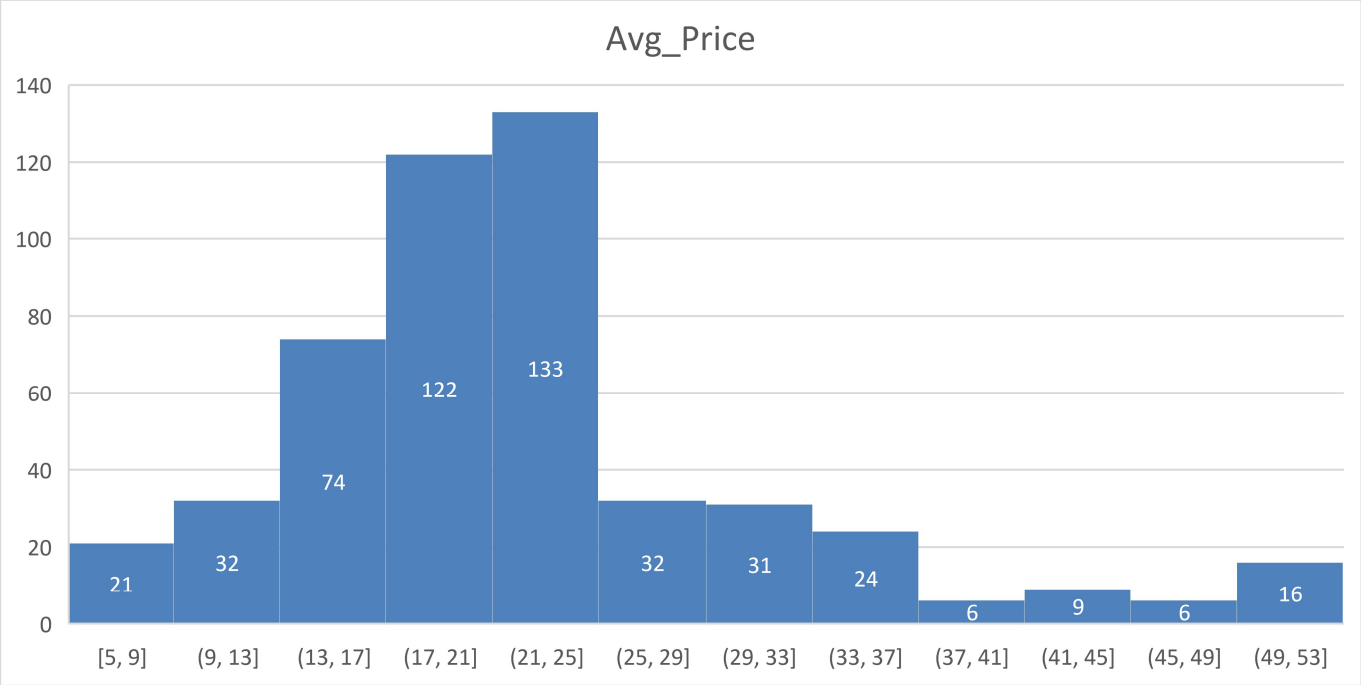
Firstly if we consider Distance variable we can analyse that maximum distance is 24 and has mode as 24. Which says that most of the houses are away from Highway.

The average tax paid is 408.2 and tax range is 524.

From the skewness of variables we can say that dataset is highly skewed.

And if we consider age variable the maximum age is 100 and mode is also 100 which says that most of the houses has age of 100.

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



From above Histogram,

We can summarise that most of the houses are from range $21000 to $25000.

We have least count of houses from range $37000 to $41000 and $45000 to $49000.

Question 3 Compute the covariance matrix. Share your observations.

	CRIME_RATE	*AGE*	*INDUS*	*NOX*	*DISTANCE*	*TAX*	*PTRATIO*	*AVG_ROOM*	*LSTAT*	*AVG_PRICE*
CRIME_RATE	8.516147873									
AGE	0.562915215	790.79								
INDUS	-0.11021518	124.27	46.9714							
NOX	0.000625308	2.3812	0.60587	0.0134						
DISTANCE	-0.22986049	111.55	35.4797	0.6157	75.66653					
TAX	-8.22932244	2397.9	831.713	13.021	1333.117	28349				
PTRATIO	0.068168906	15.905	5.68085	0.0473	8.743402	167.8	4.677726			
AVG_ROOM	0.056117778	-4.743	-1.8842	-0.0246	-1.28128	-34.5	-0.53969	0.492695216		
LSTAT	-0.88268036	120.84	29.5218	-0.488	30.32539	653.4	5.7713	-3.07365497	50.894	
AVG_PRICE	1.16201224	-97.4	-30.461	-0.4545	-30.5008	-725	-10.0907	4.484565552	-48.352	84.41955616

From above matrix we can get assumptions as :

As we can see there is high covariance value for some of the features which tells that they are higly correlated and explains the variability of the other features.

We can see that tax variable has high covariance values with each other feature except crime rate. That means tax explains a very good variability with other features.

Question 4 Create a correlation matrix of all the variables (Use Data analysis tool pack).

	CRIME_RATE	*AGE*	*INDUS*	*NOX*	*DISTANCE*	*TAX*	*PTRATIO*	*AVG_ROOM*	*LSTAT*	*AVG_PRICE*
CRIME_RATE	1									
AGE	0.006859463	1								
INDUS	-0.005510651	0.6448	1							
NOX	0.001850982	0.7315	0.7637	1						
DISTANCE	-0.009055049	0.456	0.5951	0.611	1					
TAX	-0.016748522	0.5065	0.7208	0.668	0.910228	1				
PTRATIO	0.010800586	0.2615	0.3832	0.189	0.464741	0.461	1			
AVG_ROOM	-0.02739616	-0.2403	-0.392	-0.3	-0.20985	-0.292	-0.3555	1		
LSTAT	0.042398321	0.6023	0.6038	0.591	0.488676	0.544	0.374044	-0.61380827	1	
AVG_PRICE	0.043337871	-0.377	-0.484	-0.43	-0.38163	0.469	-0.50779	0.695359947	-0.738	1

a) Which are the top 3 positively correlated pairs.

From above correlation matrix we can analyse the top 3 positively correlated pairs as

1.Distance – Tax

2.NOX – Age

3.NOX – Indus

b) Which are the top 3 negatively correlated pairs.

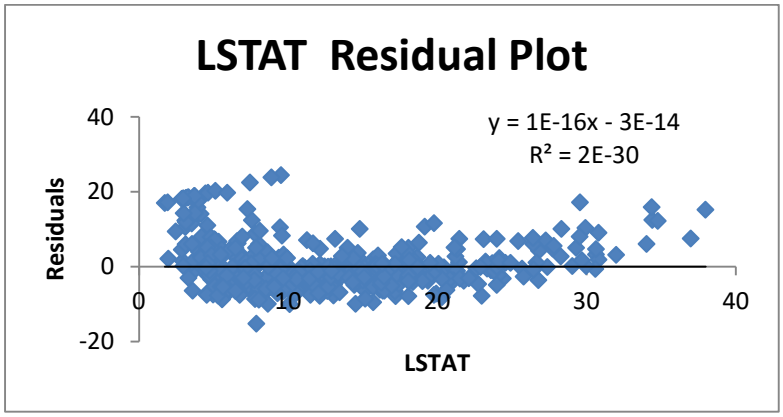
From above correlation matrix we can analyse the top 3 negatively correlated pairs as

1.LSTAT – Avg_Room

2.Avg_Price – PTRATIO

3.Avg_Price – LSTAT

Question 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?

From this model 54% of the variation in the average price is explained by the LSTAT.

The coefficient of LSTAT for the model is -0.950049354.This says that if LSTAT increases by 0.9 times then average price of house decreases 0.9times.

Intercept of LSTAT for the model is 34.55384088.

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

Yes, LSTAT is significant variable for the avg_price from this model.

As the p-value(5.08E-88) we obtained from this model is away less than 0.05.

By this we can say that LSTAT is a significant variable according to this model.

Question 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?

Regression Equation we obtained for this model is :

y = -1.358 +5.09 X0 -0.642 X1

Where y=Avg_price

X0 = avg_room

X1 = LSTAT

As per the model, avg_price for new house can be calculated as

Y= -1.358 + 5.09(7) -0.642(20) = 21.44

So ,the price for the new house is $21440 .

we can say that company is Overcharging.

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.

Yes, the performance of this model performs well compared to previous model.

From this model the linear equation we obtained is

y= -1.35 +5.09a -0.64b (Where a=Avg_room

b=LSTAT)

And Value of R square = 0.638561606 .

With this we can say that 63% of variability for average price is explained by Avg_room and LSTAT combinely and we obtained multiple R value as 0.79 which says it is highly correlated. But in previous model LSTAT alone describes 54% of variability for average price.

Question 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 Rsquare, coefficient and Intercept values. Explain the significance of each independent variable with respect to AVG_PRICE.

From the model we can obtain coefficients and p values as below:

	Coefficients	*P-value*
Intercept	29.24131526	2.54E-09
CRIME_RATE	0.048725141	0.534657
AGE	0.032770689	0.01267
INDUS	0.130551399	0.039121
NOX	-10.3211828	0.008294
DISTANCE	0.261093575	0.000138
TAX	-0.01440119	0.000251
PTRATIO	-1.074305348	6.59E-15
AVG_ROOM	4.125409152	3.89E-19
LSTAT	-0.603486589	8.91E-27

From this we can say that crime rate is not a significant variable for average price of an house as p-value is greater than 0.5.

All the features combinely explains 69% of variability for average price of a house.

NOX, TAX, PTRATIO and LSTAT have negative coefficients which says that increase in these features will result decrease in price of the house and vice-versa.

Question 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.

	Coefficients	*P-value*
Intercept	29.42847349	1.85E-09
AGE	0.03293496	0.012163
INDUS	0.130710007	0.038762
NOX	-10.27270508	0.008546
DISTANCE	0.261506423	0.000133
TAX	-0.014452345	0.000236
PTRATIO	-1.071702473	7.08E-15
AVG_ROOM	4.125468959	3.69E-19
LSTAT	-0.605159282	5.42E-27

From this we can conclude that all the features are significant variables for average price of the house.

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?

Regression stats from previous model

Regression Statistics	
Multiple R	0.832978824
R Square	0.69385372

Regression stats for this model.

Regression Statistics	
Multiple R	0.832835773
R Square	0.693615426

By comparing Multiple R and R square values for both the models we can conclude that both models perform well.

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.

	Coefficients
NOX	-10.27270508
PTRATIO	-1.071702473
LSTAT	-0.605159282
TAX	-0.014452345
AGE	0.03293496
INDUS	0.130710007
DISTANCE	0.261506423
AVG_ROOM	4.125468959
Intercept	29.42847349

If NOX is more in the locality, according to this model average price of the house will decrease by 10 times.

d) Write the regression equation from this model.

Y=0.03293496 X0 + 0.130710007 X1 -10.27270508 X3 +0.261506423 X4 - 0.014452345 X5 -1.071702473 X6 + 4.125468959 X7 -0.605159282 X8 +29.42847349

Where Y = average_Price

X0 = Age

X1 = Indus

X2 = NOX

X3 = Distance

X4 = TAX

X5 = PTRATIO

X6 = Avg_room

X7 = LSTAT

Summary:

From this Analysis ,we can conclude that all the features play a vital role in estimating the average price of the house excluding crime rate.

And few features have negative coefficients which say that increase rate in those features will decrease the average price of the house like NOX, PTRATIO, TAX and LSTAT.