ASSIGNMENT – TERRO’S REAL ESTATE AGENCY

Reported by

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Problem Statement (Situation): “Finding out the most relevant features for pricing of a house”

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 (Task):

Q1. Generate the summary statistics for each variable in the table. (Use Data analysis tool pack). Write down your observation.

>>to generate the summary statistics for each variable in table, I used data analysis tool pack.

>>In tool pack we should select the descriptive statistics and select the arrays which we want to find the summary statistics.

CRIME_RATE		*AGE*		*INDUS*		*NOX*	
Mean	4.871976	Mean	68.5749	Mean	11.13678	Mean	0.554695
Standard Error	0.12986	Standard Error	1.25137	Standard Error	0.30498	Standard Error	0.005151
Median	4.82	Median	77.5	Median	9.69	Median	0.538
Mode	3.43	Mode	100	Mode	18.1	Mode	0.538
Standard Deviation	2.921132	Standard Deviation	28.14886	Standard Deviation	6.860353	Standard Deviation	0.115878
Sample Variance	8.533012	Sample Variance	792.3584	Sample Variance	47.06444	Sample Variance	0.013428
Kurtosis	-1.18912	Kurtosis	-0.96772	Kurtosis	-1.23354	Kurtosis	-0.06467
Skewness	0.021728	Skewness	-0.59896	Skewness	0.295022	Skewness	0.729308
Range	9.95	Range	97.1	Range	27.28	Range	0.486
Minimum	0.04	Minimum	2.9	Minimum	0.46	Minimum	0.385
Maximum	9.99	Maximum	100	Maximum	27.74	Maximum	0.871
Sum	2465.22	Sum	34698.9	Sum	5635.21	Sum	280.6757
Count	506	Count	506	Count	506	Count	506

Insights

- The age of the house represent how old is that house and if that house in good condition. By the seeing statistics we can say that most of the houses are old. The mode is 100 so there are many houses which are 100 years old.
- The average industry acres per town is 11. The percentage of industry in town can increase the house price in that town.

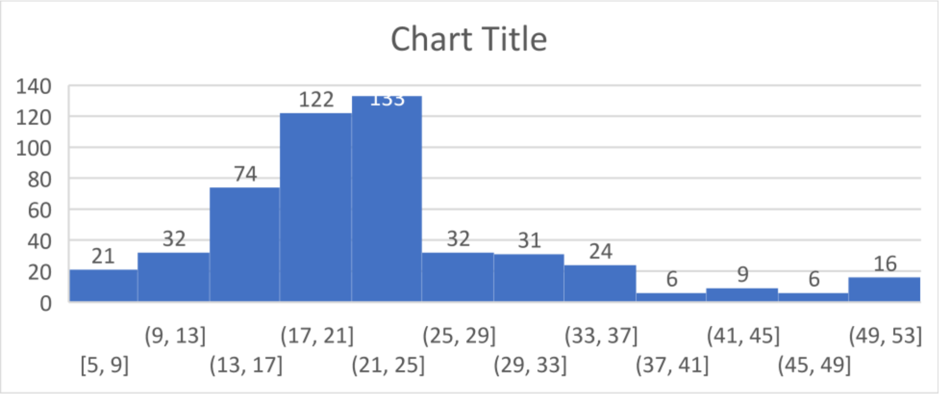
DISTANCE		*TAX*		*PTRATIO*	
Mean	9.549407115	Mean	408.2371542	Mean	18.4555336
Standard Error	0.387084894	Standard Error	7.492388692	Standard Error	0.096243568
Median	5	Median	330	Median	19.05
Mode	24	Mode	666	Mode	20.2
Standard Deviation	8.707259384	Standard Deviation	168.5371161	Standard Deviation	2.164945524
Sample Variance	75.81636598	Sample Variance	28404.75949	Sample Variance	4.686989121
Kurtosis	-0.867231994	Kurtosis	-1.142407992	Kurtosis	-0.285091383
Skewness	1.004814648	Skewness	0.669955942	Skewness	-0.802324927
Range	23	Range	524	Range	9.4
Minimum	1	Minimum	187	Minimum	12.6
Maximum	24	Maximum	711	Maximum	22
Sum	4832	Sum	206568	Sum	9338.5
Count	506	Count	506	Count	506

- The average distance (away from the highway) is 9.5 miles. The mode is 24, so there are many houses which are away from highway. The nearest house should have high price.

AVG_ROOM		*LSTAT*		*AVG_PRICE*	
Mean	6.284634387	Mean	12.65306324	Mean	22.53280632
Standard Error	0.031235142	Standard Error	0.317458906	Standard Error	0.408861147
Median	6.2085	Median	11.36	Median	21.2
Mode	5.713	Mode	8.05	Mode	50
Standard Deviation	0.702617143	Standard Deviation	7.141061511	Standard Deviation	9.197104087
Sample Variance	0.49367085	Sample Variance	50.99475951	Sample Variance	84.58672359
Kurtosis	1.891500366	Kurtosis	0.493239517	Kurtosis	1.495196944
Skewness	0.403612133	Skewness	0.906460094	Skewness	1.108098408
Range	5.219	Range	36.24	Range	45
Minimum	3.561	Minimum	1.73	Minimum	5
Maximum	8.78	Maximum	37.97	Maximum	50
Sum	3180.025	Sum	6402.45	Sum	11401.6
Count	506	Count	506	Count	506

- The town has average of 6 rooms per house. The house has minimum 3 rooms per house.
- Average price increases when the house has more rooms.

Q2. Plot a histogram of the Avg-Price variable. What do you infer?



- More than 250 houses have average price between 17 to 25.
- Most of the houses average price below 25. There are only few houses have high average price.

Q3. Compute the covariance matrix. Share your observations.

>> To compute the covariance matrix, I used data analysis tool pack.

	CRIME_RATE	*AGE*	*INDUS*	*NOX*	*DISTANCE*	*TAX*	*PTRATIO*	*AVG_ROOM*	*LSTAT*
CRIME_RATE	8.516148								
AGE	0.562915	790.7925							
INDUS	-0.11022	124.2678	46.97143						
NOX	0.000625	2.381212	0.605874	0.013401					
DISTANCE	-0.22986	111.55	35.47971	0.61571	75.66653				
TAX	-8.22932	2397.942	831.7133	13.0205	1333.117	28348.62			
PTRATIO	0.068169	15.90543	5.680855	0.047304	8.743402	167.8208	4.677726		
AVG_ROOM	0.056118	-4.74254	-1.88423	-0.02455	-1.28128	-34.5151	-0.53969	0.492695	
LSTAT	-0.88268	120.8384	29.52181	0.48798	30.32539	653.4206	5.7713	-3.07365	50.8939
AVG_PRICE	1.162012	-97.3962	-30.4605	-0.45451	-30.5008	-724.82	-10.0907	4.484566	-48.35

- Average price has positive relationship with average room per house.
- Average price increases when the house has more rooms.
- Other than Avg_room and crime_rate, all variables have negative relationship with Avg_price.
- If the house is old and the distance from highway is high, then the price of the house has to be low.

Q4. Create a correlation matrix of all the variables (Use Data analysis tool pack).

	*CRIME_*	*AGE*	*INDUS*	*NOX*	*DISTANCE*	*TAX*	*PTRATIO*	*AVG_R*	*LSTAT*	*AVG*
CRIME_RATE	1									
AGE	0.006859	1								
INDUS	-0.00551	0.644779	1							
NOX	0.001851	0.73147	0.763651	1						
DISTANCE	-0.00906	0.456022	0.595129	0.611441	1					
TAX	-0.01675	0.506456	0.72076	0.668023	0.910228	1				
PTRATIO	0.010801	0.261515	0.383248	0.188933	0.464741	0.460853	1			
AVG_ROOM	0.027396	-0.24026	-0.39168	-0.30219	-0.20985	-0.29205	-0.3555	1		
LSTAT	-0.0424	0.602339	0.6038	0.590879	0.488676	0.543993	0.374044	-0.6138	1	
AVG_PRICE	0.043338	-0.37695	-0.48373	-0.42732	-0.38163	-0.46854	-0.50779	0.69536	-0.7376	

1. **Which are the top 3 positively correlated pairs?**
    - The Tax and distance have highest positive corelation with 0.91 corelation.
    - The second highest corelation is Industry and Nitric oxides concentration with o.76 corelation.
    - The third highest corelated pair is Age and NOX with 0.73.

2. **Which are the top 3 negatively correlated pairs?**
   - The LSTAT and AVG_PRICE have lowest negatived corelation with -0.73.
   - The second lowest corelated is LSTA and average room with -0.61.
   - The third lowest corelated is AVG_PRICE and PRATIO with -0.5.

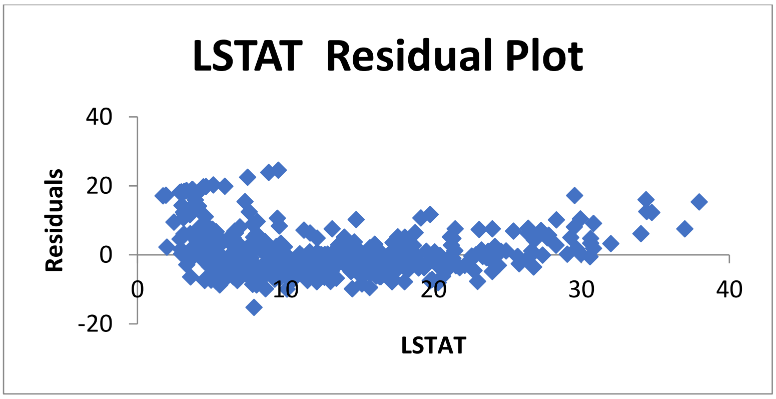
Q5. Build an initial regression model with AVG_PRICE as 'y' (Dependent variable) and LSTAT variable as Independent Variable. Generate the residual plot.

Regression Statistics	
Multiple R	0.737663
R Square	0.544146
Adjusted R Square	0.543242
Standard Error	6.21576
Observations	506

ANOVA

					Significance
	df	*SS*	*MS*	*F*	*F*
Regression	1	23243.91	23243.91	601.6179	5.08E-88
Residual	504	19472.38	38.63568		
Total	505	42716.3			

		Standard				*Upper*	*Lower*	*Upper*
	Coefficients	*Error*	*t Stat*	*P-value*	*Lower 95%*	*95%*	*95.0%*	*95.0%*
Intercept	34.55384	0.562627	61.41515	3.7E-236	33.44846	35.65922	33.44846	35.65922
LSTAT	-0.95005	0.038733	-24.5279	5.08E-88	-1.02615	-0.87395	-1.02615	-0.87395



1) **What do you infer from the Regression Summary output in terms of variance explained, coefficient value, Intercept, and the Residual plot?**
   - The p-value is very close to zero (5.08E-88), indicating that the regression model is statistically significant. We could typically reject the null hypothesis that all regression coefficients are zero.
   - The coefficient value is 34.55 so it suggests that for each unit increase in the LSTAT variable, the AVG_PRICE variable is expected to increase by 34 units.
   - The intercept of 3.7E-236 is extremely small number. The combination of a large coefficient and an extremely small intercept should be scrutinized. It might indicate issues such as collinearity, outliers, or other problems in the data.
   - The data have randomly separated residual plot, It represents the average contribution to unexplained error.

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

- Yes. The p-value associated with the F-statistic. In this case, the p-value is very close to zero (5.08E-88), indicating that the regression model is statistically significant.

Q6. Build a new Regression model including LSTAT and AVG_ROOM together as Independent variables and AVG_PRICE as dependent variable.

Regression Statistics	
Multiple R	0.973885
R Square	0.948453
Adjusted R Square	0.946366
Standard Error	5.535767
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	284181.4	142090.7	4636.712	0
Residual	504	15444.93	30.64471		
Total	506	299626.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AVG_ROOM	4.906906	0.070193	69.90558	1.6E-261	4.768998	5.044814	4.768998	5.044814
LSTAT	-0.65574	0.030559	-21.4585	4.81E-73	-0.71578	-0.5957	-0.71578	-0.5957

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: AVG PRICE=coefficient of Avg_room * ROOM + coefficient of LSTAT * LSTAT
- AVG_PRICE = 4.9*7-0.65*20 = 21.3
- The average price of the house which has 7 rooms and has a value of 20 for L_STAT is 21300 USD. But the company quoting a value of 30000 USD which 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.

- The performance of this model better than the previous model. The adjusted R-square of previous model was 0.54 and this model's adjusted R-square is 0.94. This model's R-square is higher than the previous one.

Q7. 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 of each independent variable with respect to AVG_PRICE.

Regression Statistics	
Multiple R	0.832979
R Square	0.693854
Adjusted R Square	0.688299
Standard Error	5.134764
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	29638.86	3293.207	124.9045049	1.9328E-121
Residual	496	13077.43	26.3658		
Total	505	42716.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	29.24132	4.817126	6.070283	2.53978E-09	19.77682784	38.7058	19.77683	38.7058
CRIME_RATE	0.048725	0.078419	0.621346	0.534657201	-0.105348544	0.202799	-0.10535	0.202799
AGE	0.032771	0.013098	2.501997	0.012670437	0.00703665	0.058505	0.007037	0.058505
INDUS	0.130551	0.063117	2.068392	0.03912086	0.006541094	0.254562	0.006541	0.254562
NOX	-10.3212	3.894036	-2.65051	0.008293859	-17.97202279	-2.67034	-17.972	-2.67034
DISTANCE	0.261094	0.067947	3.842603	0.000137546	0.127594012	0.394593	0.127594	0.394593
TAX	-0.0144	0.003905	-3.68774	0.000251247	-0.022073881	-0.00673	-0.02207	-0.00673
PTRATIO	-1.07431	0.133602	-8.0411	6.58642E-15	-1.336800438	-0.81181	-1.3368	-0.81181
AVG_ROOM	4.125409	0.442759	9.317505	3.89287E-19	3.255494742	4.995324	3.255495	4.995324
LSTAT	-0.60349	0.053081	-11.3691	8.91071E-27	-0.70777824	-0.49919	-0.70778	-0.49919

- Regression of all variables as independent and avg_price as dependent variable has high coefficient and low p-value.
- The p-value is very close to zero, indicating that the regression model is statistically significant. We could typically reject the null hypothesis that all regression coefficients are zero.
- The adjusted R-square of this model is 0.68. which is considered as low.
- All variables except Crime_rate have low p-value, which makes overall regression model is significant.
- By that LSTAT, PTRatio and AVG_ROOM variables have high significance.
- AGE,INDUS,NOX,Distance and Tax have low significance.
- They are all reject the Null hypothesis.

Q8. 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:

Regression Statistics	
Multiple R	0.976229
R Square	0.953023
Adjusted R Square	0.950355
Standard Error	5.316393
Observations	506

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	285550.9	35693.86	1262.872	0
Residual	498	14075.49	28.26403		
Total	506	299626.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AGE	0.011474	0.013063	0.878344	0.380181	-0.01419	0.03714	-0.01419	0.03714
INDUS	0.049527	0.06389	0.77519	0.438595	-0.076	0.175055	-0.076	0.175055
NOX	1.282534	3.525404	0.363798	0.716163	-5.64396	8.209033	-5.64396	8.209033
DISTANCE	0.094786	0.064447	1.470754	0.141989	-0.03184	0.221409	-0.03184	0.221409
TAX	-0.01016	0.003977	-2.55407	0.010944	-0.01797	-0.00234	-0.01797	-0.00234
PTRATIO	-0.49054	0.097223	-5.0455	6.35E-07	-0.68156	-0.29952	-0.68156	-0.29952
AVG_ROOM	6.206434	0.293687	21.13282	3.08E-71	5.629416	6.783452	5.629416	6.783452
LSTAT	-0.49745	0.051776	-9.60773	3.65E-20	-0.59918	-0.39573	-0.59918	-0.39573

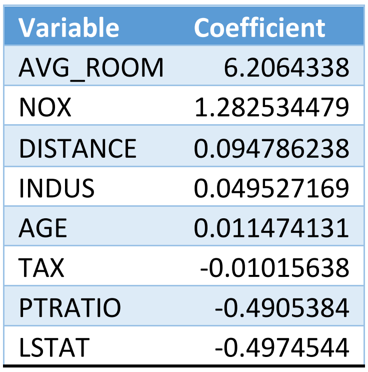
a) Interpret the output of this model.

- The multiple regression model is highly significant (p-value < 0.05), suggesting that at least one of the independent variables is associated with the dependent variable.
- The model explains a substantial portion of the variance in the dependent variable .
- The adjusted R-squared is close to the R-squared value, indicating that the inclusion of multiple predictors does not significantly decrease the goodness of fit.

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?

- This model's R-square is 0.95, which is considered as a good R-Square.
- By selecting significant variables, we have good model which has high significance and R-square.
- This 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?



Variable	Coefficient
AVG_ROOM	6.2064338
NOX	1.282534479
DISTANCE	0.094786238
INDUS	0.049527169
AGE	0.011474131
TAX	-0.01015638
PTRATIO	-0.4905384
LSTAT	-0.4974544

- If the value of NOX is more in a locality in this town, the average price will be more too. Because NOX have positive relationship with a AVG_Price.

c) Write the regression equation from this model.

- Regression equation
  = (6.2 * avg_room) +(1.28*NOX) + (0.09*Distance) + (0.04*INDUS) + (0.01*Age)
  + (-0.01*TAX) + (-0.49*PTRATIO) + (-0.49*LSTAT)