# Terro's Real Estate Agency Project

By Gurumurthy G D

## 1. The first step to any project is understanding the data. So, for this step, generate the summary statistics for each of the variables. What do you observe?

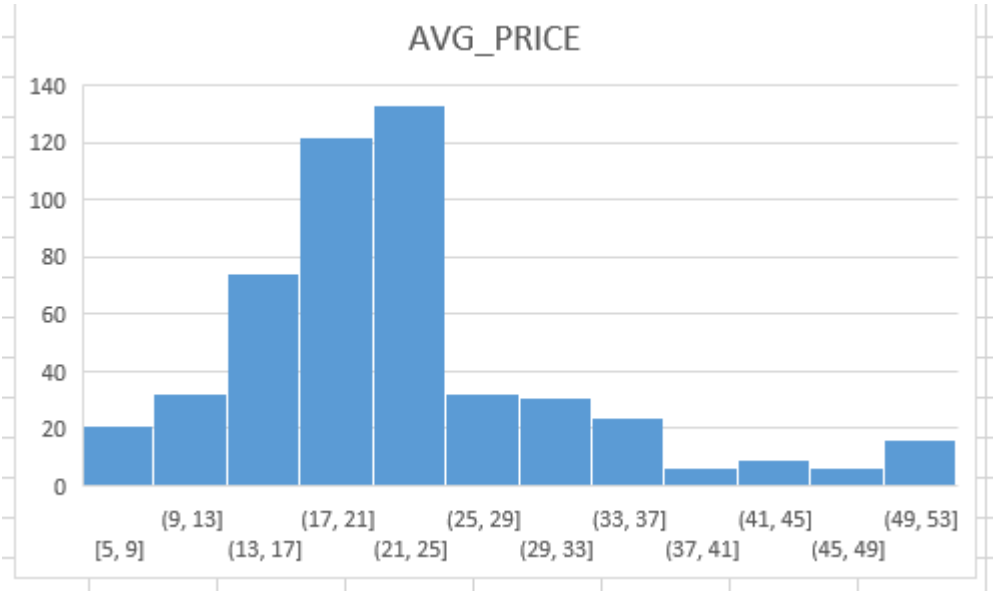
| CRIME_RATE | | AGE | | INDUS | | NOX | | DISTANCE | | TAX | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 4.872 | Mean | 68.575 | Mean | 11.137 | Mean | 0.5547 | Mean | 9.5494 | Mean | 408.24 |
| Standard Error | 0.1299 | Standard Error | 1.2514 | Standard Error | 0.305 | Standard Error | 0.0052 | Standard Error | 0.3871 | Standard Error | 7.4924 |
| Median | 4.82 | Median | 77.5 | Median | 9.69 | Median | 0.538 | Median | 5 | Median | 330 |
| Mode | 3.43 | Mode | 100 | Mode | 18.1 | Mode | 0.538 | Mode | 24 | Mode | 666 |
| Standard Deviatior | 2.9211 | Standard Deviatio | 28.149 | Standard Deviatio | 6.8604 | Standard Deviation | 0.1159 | Standard Deviatio | 8.7073 | Standard Deviation | 168.54 |
| Sample Variance | 8.533 | Sample Variance | 792.36 | Sample Variance | 47.064 | Sample Variance | 0.0134 | Sample Variance | 75.816 | Sample Variance | 28405 |
| Kurtosis | -1.189 | Kurtosis | -0.968 | Kurtosis | -1.234 | Kurtosis | -0.065 | Kurtosis | -0.867 | Kurtosis | -1.142 |
| Skewness | 0.0217 | Skewness | -0.599 | Skewness | 0.295 | Skewness | 0.7293 | Skewness | 1.0048 | Skewness | 0.67 |
| Range | 9.95 | Range | 97.1 | Range | 27.28 | Range | 0.486 | Range | 23 | Range | 524 |
| Minimum | 0.04 | Minimum | 2.9 | Minimum | 0.46 | Minimum | 0.385 | Minimum | 1 | Minimum | 187 |
| Maximum | 9.99 | Maximum | 100 | Maximum | 27.74 | Maximum | 0.871 | Maximum | 24 | Maximum | 711 |
| Sum | 2465.2 | Sum | 34699 | Sum | 5635.2 | Sum | 280.68 | Sum | 4832 | Sum | 206568 |
| Count | 506 | Count | 506 | Count | 506 | Count | 506 | Count | 506 | Count | 506 |

| PTRATIO | | AVG_ROOM | | LSTAT | | AVG_PRICE | |
|---|---|---|---|---|---|---|---|
| Mean | 18.456 | Mean | 6.2846 | Mean | 12.653 | Mean | 22.533 |
| Standard Error | 0.0962 | Standard Error | 0.0312 | Standard Error | 0.3175 | Standard Error | 0.4089 |
| Median | 19.05 | Median | 6.2085 | Median | 11.36 | Median | 21.2 |
| Mode | 20.2 | Mode | 5.713 | Mode | 8.05 | Mode | 50 |
| Standard Deviatior | 2.1649 | Standard Deviatio | 0.7026 | Standard Deviatio | 7.1411 | Standard Deviation | 9.1971 |
| Sample Variance | 4.687 | Sample Variance | 0.4937 | Sample Variance | 50.995 | Sample Variance | 84.587 |
| Kurtosis | -0.285 | Kurtosis | 1.8915 | Kurtosis | 0.4932 | Kurtosis | 1.4952 |
| Skewness | -0.802 | Skewness | 0.4036 | Skewness | 0.9065 | Skewness | 1.1081 |
| 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 | Sum | 6402.5 | Sum | 11402 |
| Count | 506 | Count | 506 | Count | 506 | Count | 506 |

- From the given data, the mean=68.575 shows the average age value in the town.
- From the median=77.5, it clearly shows that most of them are aged persons in the town.
- All the given variables except the PT-ratio have a Positive skewness.
- There is minimum outlier data in Crime rate, NOX and

Avg. Room.

## 2. Plot the histogram of the Avg_Price Variable. What do you infer?




- AVERAGE PRICE is a dependent variable, which has a very few outlier data and it is Rightly skewed with a leptokurtic kurtosis.
- There are 133 Houses with the price range of 21000 dollars to 25000 dollars.

## 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 | 790.7925 | | | | | | | | |
| INDUS | -0.110215175 | 124.2678 | 46.97143 | | | | | | | |
| NOX | 0.000625308 | 2.381212 | 0.605874 | 0.013401 | | | | | | |
| DISTANCE | -0.229860488 | 111.55 | 35.47971 | 0.61571 | 75.66653 | | | | | |
| TAX | -8.229322439 | 2397.942 | 831.7133 | 13.0205 | 1333.117 | 28348.62 | | | | |
| PTRATIO | 0.068168906 | 15.90543 | 5.680855 | 0.047304 | 8.743402 | 167.8208 | 4.677726 | | | |
| AVG_ROOM | 0.056117778 | -4.74254 | -1.88423 | -0.02455 | -1.28128 | -34.5151 | -0.53969 | 0.492695216 | | |
| LSTAT | -0.882680362 | 120.8384 | 29.52181 | 0.48798 | 30.32539 | 653.4206 | 5.7713 | -3.07365497 | 50.89398 | |
| AVG_PRICE | 1.16201224 | -97.3962 | -30.4605 | -0.45451 | -30.5008 | -724.82 | -10.0907 | 4.484565552 | -48.3518 | 84.41955616 |

There are both Positive covariance and Negative covariance in the above matrix.

The most positive covariance value is 2397.942 (Tax and Age)

The most Negative covariance value is -724.82 (Tax and Avg_price)

## 4. Create a correlation matrix of all the variables as shown in the Videos and various case studies. State top 3 positively correlated pairs and top 3 negatively correlated pairs.

| | CRIME_RATE | AGE | INDUS | NOX | DISTANCE | TAX | PTRATIO | AVG_ROOM | LSTAT | AVG_PRICE |
|---|---|---|---|---|---|---|---|---|---|---|
| CRIME_RATE | 1 | | | | | | | | | |
| AGE | 0.006859463 | 1 | | | | | | | | |
| INDUS | -0.005510651 | 0.644779 | 1 | | | | | | | |
| NOX | 0.001850982 | 0.73147 | 0.763651 | 1 | | | | | | |
| DISTANCE | -0.009055049 | 0.456022 | 0.595129 | 0.611441 | 1 | | | | | |
| TAX | -0.016748522 | 0.506456 | 0.72076 | 0.668023 | 0.91022819 | 1 | | | | |
| PTRATIO | 0.010800586 | 0.261515 | 0.383248 | 0.188933 | 0.46474118 | 0.460853 | 1 | | | |
| AVG_ROOM | 0.02739616 | -0.24026 | -0.39168 | -0.30219 | -0.2098467 | -0.29205 | -0.3555 | 1 | | |
| LSTAT | -0.042398321 | 0.602339 | 0.6038 | 0.590879 | 0.48867633 | 0.543993 | 0.374044 | -0.61380827 | 1 | |
| AVG_PRICE | 0.043337871 | -0.37695 | -0.48373 | -0.42732 | -0.3816262 | -0.46854 | -0.50779 | 0.695359947 | -0.73766 | 1 |

**Top 3 Positive correlated values**

- Tax and Distance
- Indus and Nox
- Age and Nox

**Top 3 Negative Correlated values**

- Avg_price and Lstat
- Avg_room and Lstat
- Avg_price and PT ratio

## 5. Build an initial regression model with AVG_PRICE as the y or the Dependent variable and LSTAT variable as the Independent Variable. Generate the residual plot too.

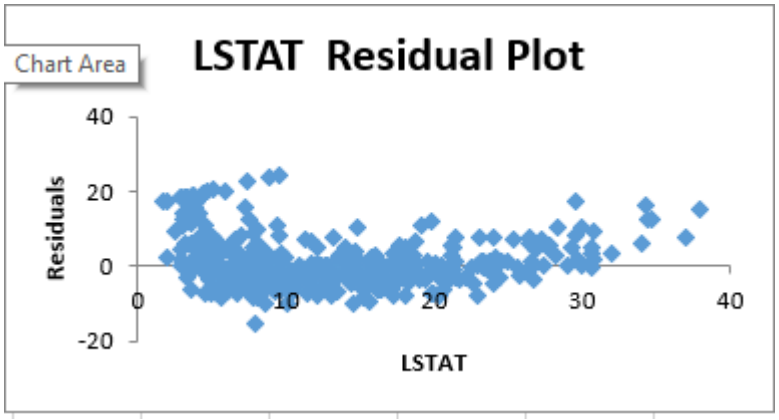
SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.7376627 |
| R Square | 0.5441463 |
| Adjusted R | 0.5432418 |
| Standard Er | 6.2157604 |
| Observatior | 506 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 23243.914 | 23243.91 | 601.6179 | 5.0811E-88 |
| Residual | 504 | 19472.38142 | 38.63568 | | |
| Total | 505 | 42716.29542 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 34.553841 | 0.562627355 | 61.41515 | 3.7E-236 | 33.44845704 | 35.6592247 | 33.44845704 | 35.65922472 |
| LSTAT | -0.9500494 | 0.038733416 | -24.5279 | 5.08E-88 | -1.0261482 | -0.8739505 | -1.0261482 | -0.873950508 |




**a. What do you infer from the Regression Summary Output in terms of variance explained, coefficient value, Intercept and the Residual plot?**

- The value of the variance is less than 0.05, so the model is highly significant.
- From the residual plot, we can see that there is some outlier in a data.

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

Yes, LSTAT variable is significant for the analysed model.

**6. Build another instance of the Regression model but this time including LSTAT and AVG_ROOM together as independent variables and AVG_PRICE as the dependentvariable?**

SUMMARY OUTPUT

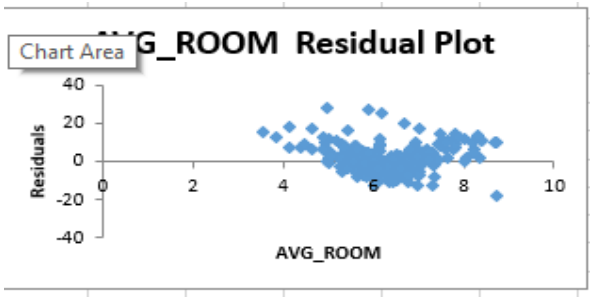
| *Regression Statistics* | |
|---|---|
| Multiple | 0.7991005 |
| R Square | 0.63856161 |
| Adjusted | 0.63712448 |
| Standard | 5.54025737 |
| Observat | 506 |

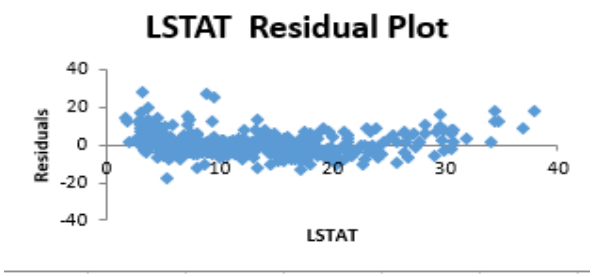
ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regressi | 2 | 27276.98621 | | 444.331 | 7.01E-112 |
| Residual | 503 | 15439.3091 | | | |
| Total | 505 | 42716.29542 | | | |

Plot Area

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -1.3582728 | 3.17282778 | -0.428095 | 0.66876 | -7.5919003 | 4.8753547 | -7.591900282 | 4.875354658 |
| AVG_ROO | 5.09478798 | 0.4444655 | 11.46273 | 3.5E-27 | 4.2215504 | 5.9680255 | 4.221550436 | 5.968025533 |
| LSTAT | -0.6423583 | 0.043731465 | -14.6887 | 6.7E-41 | -0.7282772 | -0.55644 | -0.728277167 | -0.556439501 |



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?**

BY using a regression equation, the AVG_PRICE value is 21.4581. Comparing to the quoting value, the company is **overcharging** for the property.

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

- Previous model Adj. R-square= 0.543241825954707
- New model Adj. R-square= 0.637124475470123

- Yes, the performance of this new model is better than the previous model by comparing to the value of adjusted R-square.

**7. Now, build a Regression model with all variables. AVG_PRICE shall be the Dependent Variable. Interpret the output in terms of adjusted R-square, coefficient and Intercept values, Significance of variables with respect to AVG_price. Explain?**

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.8329788 | | | | | | | |
| R Square | 0.6938537 | | | | | | | |
| Adjusted R Square | 0.6882986 | | | | | | | |
| Standard Error | 5.1347635 | | | | | | | |
| Observations | 506 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *ignificance F* | | | |
| Regression | 9 | 29638.8605 | 3293.21 | 124.905 | 2E-121 | | | |
| Residual | 496 | 13077.43492 | 26.3658 | | | | | |
| Total | 505 | 42716.29542 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 29.241315 | 4.817125596 | 6.07028 | 2.5E-09 | 19.7768 | 38.70580267 | 19.77682784 | 38.705803 |
| CRIME_RATE | 0.0487251 | 0.078418647 | 0.62135 | 0.53466 | -0.10535 | 0.202798827 | -0.10534854 | 0.2027988 |
| AGE | 0.0327707 | 0.013097814 | 2.502 | 0.01267 | 0.00704 | 0.058504728 | 0.00703665 | 0.0585047 |
| INDUS | 0.1305514 | 0.063117334 | 2.06839 | 0.03912 | 0.00654 | 0.254561704 | 0.006541094 | 0.2545617 |
| NOX | -10.32118 | 3.894036256 | -2.6505 | 0.00829 | -17.972 | -2.67034281 | -17.9720228 | -2.6703428 |
| DISTANCE | 0.2610936 | 0.067947067 | 3.8426 | 0.00014 | 0.12759 | 0.394593138 | 0.127594012 | 0.3945931 |
| TAX | -0.014401 | 0.003905158 | -3.6877 | 0.00025 | -0.02207 | -0.0067285 | -0.02207388 | -0.0067285 |
| PTRATIO | -1.074305 | 0.133601722 | -8.0411 | 6.6E-15 | -1.3368 | -0.81181026 | -1.33680044 | -0.8118103 |
| AVG_ROOM | 4.1254092 | 0.442758999 | 9.3175 | 3.9E-19 | 3.25549 | 4.995323561 | 3.255494742 | 4.9953236 |
| LSTAT | -0.603487 | 0.053081161 | -11.369 | 8.9E-27 | -0.70778 | -0.49919494 | -0.70777824 | -0.4991949 |

By seeing the coefficient from the regression data, we can say that

- Avg. price and Avg. room variables are directly proportional.
- NOX and Avg. Price are inversely proportional to each other.

The significance variables in this model are:

- AGE
- INDUS
- NOX
- DISTANCE
- TAX
- PTRATIO
- AVG_ROOM
- LSTAT

**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.**

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.83283577 |
| R Square | 0.69361543 |
| Adjusted R Square | 0.68868368 |
| Standard Error | 5.13159111 |
| Observations | 506 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 8 | 29628.68142 | 3703.59 | 140.643 | 1.911E-122 |
| Residual | 497 | 13087.61399 | 26.3332 | | |
| Total | 505 | 42716.29542 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 29.4284735 | 4.804728624 | 6.1249 | 1.8E-09 | 19.98838959 | 38.86856 | 19.98839 | 38.8685574 |
| AGE | 0.03293496 | 0.013087055 | 2.51661 | 0.01216 | 0.007222187 | 0.058648 | 0.0072222 | 0.05864773 |
| INDUS | 0.13071001 | 0.063077823 | 2.0722 | 0.03876 | 0.006777942 | 0.254642 | 0.0067779 | 0.25464207 |
| NOX | -10.272705 | 3.890849222 | -2.6402 | 0.00855 | -17.9172457 | -2.62816 | -17.917246 | -2.6281645 |
| DISTANCE | 0.26150642 | 0.067901841 | 3.85124 | 0.00013 | 0.128096375 | 0.394916 | 0.1280964 | 0.39491647 |
| TAX | -0.0144523 | 0.003901877 | -3.7039 | 0.00024 | -0.02211855 | -0.00679 | -0.0221186 | -0.0067861 |
| PTRATIO | -1.0717025 | 0.133453529 | -8.0305 | 7.1E-15 | -1.33390511 | -0.8095 | -1.3339051 | -0.8094998 |
| AVG_ROOM | 4.12546896 | 0.44248544 | 9.3234 | 3.7E-19 | 3.256096304 | 4.994842 | 3.2560963 | 4.99484161 |
| LSTAT | -0.6051593 | 0.0529801 | -11.422 | 5.4E-27 | -0.70925186 | -0.50107 | -0.7092519 | -0.5010667 |

**a. Interpret the output of this model.**

This model has a Better Adjusted R-square value of 68.86%.

**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?**

The New model performs well than the previous model by comparing the value of an Adjusted R-square value.

**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?**

| Column1 | Column2 |
|---|---|
| NOX | -10.272705 |
| PTRATIO | -1.0717025 |
| LSTAT | -0.6051593 |
| TAX | -0.0144523 |
| AGE | 0.03293496 |
| INDUS | 0.13071001 |
| DISTANCE | 0.26150642 |
| AVG_ROOM | 4.12546896 |

The **AVERAGE_PRICE** is HIGH, if the NOX is LOW

**d. Write the regression equation from this model.**

Multi-Linear regression equation:

$Y=m_1x_1+ m_2x_2+ m_3x_3+ m_4x_4+ m_5x_5+ m_6x_6+ m_7x_7+ m_8x_8 + c$

Multi-linear regression equation of this model:

$Y= -10.2727050815094x_1 -1.07170247269449x_2 - 0.605159282035406x_3 -0.0144523450364819x_4+ 0.0329349604286303x_5+ 0.130710006682182x_6+ 0.261506423001819x_7+ 4.12546895908474x_8 + 29.4284734939458$

Y= Predicted Variable

m= weight of the variable

$X_n$= Independent variable

C= Intercept