SARANRAM K C

Assignment – Terro’s real estate agency

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 | 4.871976285 | Mean | 68.57490119 | Mean | 11.13677866 |
| Standard Error | 0.129860152 | Standard Error | 1.251369525 | Standard Error | 0.304979888 |
| Median | 4.82 | Median | 77.5 | Median | 9.69 |
| Mode | 3.43 | Mode | 100 | Mode | 18.1 |
| Standard Deviation | 2.921131892 | Standard Deviation | 28.14886141 | Standard Deviation | 6.860352941 |
| Sample Variance | 8.533011532 | Sample Variance | 792.3583985 | Sample Variance | 47.06444247 |
| Kurtosis | -1.189122464 | Kurtosis | -0.967715594 | Kurtosis | -1.233539601 |
| Skewness | 0.021728079 | Skewness | -0.59896264 | Skewness | 0.295021568 |
| 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 |

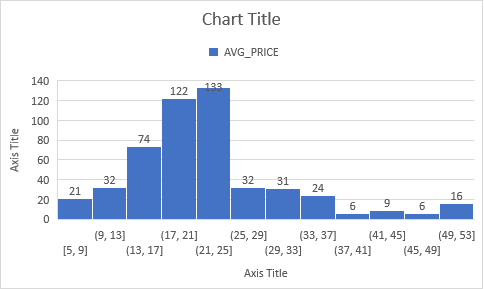
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***NOX*** |  | ***DISTANCE*** |  | ***TAX*** |  |
|  |  |  |  |  |  |
| Mean | 0.554695059 | Mean | 9.549407115 | Mean | 408.2371542 |
| Standard Error | 0.005151391 | Standard Error | 0.387084894 | Standard Error | 7.492388692 |
| Median | 0.538 | Median | 5 | Median | 330 |
| Mode | 0.538 | Mode | 24 | Mode | 666 |
| Standard Deviation | 0.115877676 | Standard Deviation | 8.707259384 | Standard Deviation | 168.5371161 |
| Sample Variance | 0.013427636 | Sample Variance | 75.81636598 | Sample Variance | 28404.75949 |
| Kurtosis | -0.064667133 | Kurtosis | -0.867231994 | Kurtosis | -1.142407992 |
| Skewness | 0.729307923 | Skewness | 1.004814648 | Skewness | 0.669955942 |
| 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*** |  |
|  |  |  |  |  |  |
| Mean | 18.4555336 | Mean | 6.284634387 | Mean | 12.65306324 |
| Standard Error | 0.096243568 | Standard Error | 0.031235142 | Standard Error | 0.317458906 |
| Median | 19.05 | Median | 6.2085 | Median | 11.36 |
| Mode | 20.2 | Mode | 5.713 | Mode | 8.05 |
| Standard Deviation | 2.164945524 | Standard Deviation | 0.702617143 | Standard Deviation | 7.141061511 |
| Sample Variance | 4.686989121 | Sample Variance | 0.49367085 | Sample Variance | 50.99475951 |
| Kurtosis | -0.285091383 | Kurtosis | 1.891500366 | Kurtosis | 0.493239517 |
| Skewness | -0.802324927 | Skewness | 0.403612133 | Skewness | 0.906460094 |
| Range | 9.4 | Range | 5.219 | Range | 36.24 |
| Minimum | 12.6 | Minimum | 3.561 | Minimum | 1.73 |
| Maximum | 22 | Maximum | 8.78 | Maximum | 37.97 |
| Sum | 9338.5 | Sum | 3180.025 | Sum | 6402.45 |
| Count | 506 | Count | 506 | Count | 506 |

|  |  |
| --- | --- |
| ***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 |

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| --- | --- | --- | --- |
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| **Summary Statistics:** | |  |  |
|  |  |  |  |
| \*Highest Standard Deviation value is 168.53711 in TAX field | | | |
| \*Lowest Standard Deviation value is 0.1158 in NOX | | | |
|  |  |  |  |
| \*Highest Mean value is 408.2371 in TAX field | | |  |
| \*Lowest Mean value is 0.55469 in NOX | | |  |
|  |  |  |  |

1. Plot a histogram of the Avg\_Price variable. What do you infer?



**INFER:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| \*X-axis: Range of Data Brackets Starts [5,9] and end to [49,53] | | | | | |  |  |  |  |  |
| \*Y-axis: The Y-axis the average price around 0 to 140 its shows in Y-axis on the Histogram | | | | | | | | |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| \*The Highest values is 133 of AVG\_PRICE in between [21,25] and the lowest value is 6 [37,41] and [41,49].  3) Compute the covariance matrix. Share your observations | | | | | | | | | | |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *CRIME\_RATE* | *AGE* | *INDUS* | *NOX* | *DISTANCE* | *TAX* | *PTRATIO* | *AVG\_ROOM* | *LSTAT* | *AVG\_PRICE* |  |
| CRIME\_RATE | 8.516147873 |  |  |  |  |  |  |  |  |  |  |
| AGE | 0.562915215 | 790.7924728 |  |  |  |  |  |  |  |  |  |
| INDUS | -0.110215175 | 124.2678282 | 46.97142974 |  |  |  |  |  |  |  |  |
| NOX | 0.000625308 | 2.381211931 | 0.605873943 | 0.013401099 |  |  |  |  |  |  |  |
| DISTANCE | -0.229860488 | 111.5499555 | 35.47971449 | 0.615710224 | 75.66653127 |  |  |  |  |  |  |
| TAX | -8.229322439 | 2397.941723 | 831.7133331 | 13.02050236 | 1333.116741 | 28348.6236 |  |  |  |  |  |
| PTRATIO | 0.068168906 | 15.90542545 | 5.680854782 | 0.047303654 | 8.74340249 | 167.8208221 | 4.677726296 |  |  |  |  |
| AVG\_ROOM | 0.056117778 | -4.74253803 | -1.884225427 | -0.024554826 | -1.281277391 | -34.51510104 | -0.539694518 | 0.492695216 |  |  |  |
| LSTAT | -0.882680362 | 120.8384405 | 29.52181125 | 0.487979871 | 30.32539213 | 653.4206174 | 5.771300243 | -3.073654967 | 50.89397935 |  |  |
| AVG\_PRICE | 1.16201224 | -97.39615288 | -30.46050499 | -0.454512407 | -30.50083035 | -724.8204284 | -10.09067561 | 4.484565552 | -48.35179219 | 84.41955616 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Positive Covariance** | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | \*The Highest Positive Covariance is Tax vs Tax Value is (28348.623) | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **Negative Covariance** | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | \*The Lowest Negative Covariance is Avg\_Price vs Tax Value is (-724.820) | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |

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.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *CRIME\_RATE* | *AGE* | *INDUS* | *NOX* | *DISTANCE* | *TAX* | *PTRATIO* | *AVG\_ROOM* | *LSTAT* | *AVG\_PRICE* |
| CRIME\_RATE | 1 |  |  |  |  |  |  |  |  |  |
| AGE | 0.006859463 | 1 |  |  |  |  |  |  |  |  |
| INDUS | -0.005510651 | 0.644778511 | 1 |  |  |  |  |  |  |  |
| NOX | 0.001850982 | 0.731470104 | 0.763651447 | 1 |  |  |  |  |  |  |
| DISTANCE | -0.009055049 | 0.456022452 | 0.595129275 | 0.611440563 | 1 |  |  |  |  |  |
| TAX | -0.016748522 | 0.506455594 | 0.72076018 | 0.6680232 | 0.910228189 | 1 |  |  |  |  |
| PTRATIO | 0.010800586 | 0.261515012 | 0.383247556 | 0.188932677 | 0.464741179 | 0.460853035 | 1 |  |  |  |
| AVG\_ROOM | 0.02739616 | -0.240264931 | -0.391675853 | -0.302188188 | -0.209846668 | -0.292047833 | -0.355501495 | 1 |  |  |
| LSTAT | -0.042398321 | 0.602338529 | 0.603799716 | 0.590878921 | 0.488676335 | 0.543993412 | 0.374044317 | -0.613808272 | 1 |  |
| AVG\_PRICE | 0.043337871 | -0.376954565 | -0.48372516 | -0.427320772 | -0.381626231 | -0.468535934 | -0.507786686 | 0.695359947 | -0.737662726 | 1 |
|  |  |  |  |  |  |  |  |  |  |  |
|  | a) | The Top 3 positively correlated pairs are | | |  |  |  |  |  |  |
|  |  | (TAX vs DISTANCE) | | 0.9102 |  |  |  |  |  |  |
|  |  | (NOX vs INDUS) | | 0.7636 |  |  |  |  |  |  |
|  |  | (AVG\_PRICE vs AVG\_ROOM) | | 0.6953 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | b) | The Top 3 Negative correlated pairs are | | |  |  |  |  |  |  |
|  |  | (AVG\_ROOM vs PTRATIO) | | -0.3555 |  |  |  |  |  |  |
|  |  | (LSTAT vs AVG\_ROOM) | | -0.6138 |  |  |  |  |  |  |
|  |  | (AVG\_PRICE vs LSTAT) | | -0.7376 |  |  |  |  |  |  |

5) Build an initial regression model with AVG\_PRICE as ‘y’ (Dependent variable) and LSTAT variable as Independent Variable. Generate the residual plot. (8 marks) 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 | 0.737662726 |  |  |  |  |
| R Square | 0.544146298 |  |  |  |  |
| Adjusted R Square | 0.543241826 |  |  |  |  |
| Standard Error | 6.215760405 |  |  |  |  |
| Observations | 506 |  |  |  |  |
|  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 1 | 23243.914 | 23243.914 | 602 | 5.0811E-88 |
| Residual | 504 | 19472.38142 | 38.63567742 |  |  |
| Total | 505 | 42716.29542 |  |  |  |
|  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* |
| Intercept | 34.55384088 | 0.562627355 | 61.41514552 | 0 | 33.44845704 |
| LSTAT | -0.950049354 | 0.038733416 | -24.52789985 | 0 | -1.0261482 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| RESIDUAL OUTPUT |  |  |  |  |  |
|  |  |  |  |  |  |
| *Observation* | *Predicted AVG\_PRICE* | *Residuals* |  |  |  |
| 1 | 29.8225951 | -5.822595098 |  |  |  |
| 2 | 25.87038979 | -4.270389786 |  |  |  |
| 3 | 30.72514198 | 3.974858016 |  |  |  |
| 4 | 31.76069578 | 1.639304221 |  |  |  |
| 5 | 29.49007782 | 6.709922176 |  |  |  |
| 6 | 29.60408375 | -0.904083746 |  |  |  |
| 7 | 22.74472741 | 0.155272588 |  |  |  |
| 8 | 16.36039575 | 10.73960425 |  |  |  |
| 9 | 6.118863721 | 10.38113628 |  |  |  |
| 10 | 18.30799693 | 0.59200307 |  |  |  |
| 11 | 15.1253316 | -0.125331595 |  |  |  |
| 12 | 21.94668596 | -3.046685955 |  |  |  |
| 13 | 19.62856553 | 2.071434468 |  |  |  |
| 14 | 26.70643322 | -6.306433217 |  |  |  |
| 15 | 24.80633451 | -6.60633451 |  |  |  |
| 16 | 26.50692285 | -6.606922853 |  |  |  |
| 17 | 28.30251613 | -5.202516132 |  |  |  |
| 18 | 20.61661686 | -3.11661686 |  |  |  |
| 19 | 23.44776393 | -3.247763934 |  |  |  |
| 20 | 23.83728417 | -5.637284169 |  |  |  |
| 21 | 14.58380346 | -0.983803463 |  |  |  |
| 22 | 21.41465832 | -1.814658317 |  |  |  |
| 23 | 16.76891698 | -1.568916977 |  |  |  |
| 24 | 15.66685973 | -1.166859727 |  |  |  |
| 25 | 19.06803641 | -3.468036413 |  |  |  |
| 26 | 18.86852605 | -4.968526049 |  |  |  |
| 27 | 20.48360995 | -3.88360995 |  |  |  |
| 28 | 18.13698805 | -3.336988046 |  |  |  |
| 29 | 22.39320915 | -3.993209151 |  |  |  |
| 30 | 23.17224962 | -2.172249621 |  |  |  |
| 31 | 13.08272548 | -0.382725484 |  |  |  |
| 32 | 22.16519731 | -7.665197306 |  |  |  |
| 33 | 8.227973287 | 4.972026713 |  |  |  |
| 34 | 17.12043524 | -4.020435238 |  |  |  |
| 35 | 15.22983702 | -1.729837024 |  |  |  |
| 36 | 25.35736314 | -6.457363135 |  |  |  |
| 37 | 23.71377775 | -3.713777753 |  |  |  |
| 38 | 26.22190805 | -5.221908047 |  |  |  |
| 39 | 24.92984093 | -0.229840926 |  |  |  |
| 40 | 30.44962767 | 0.350372329 |  |  |  |
| 41 | 32.67274316 | 2.227256841 |  |  |  |
| 42 | 29.95560201 | -3.355602007 |  |  |  |
| 43 | 29.03405413 | -3.734054134 |  |  |  |
| 44 | 27.48547369 | -2.785473687 |  |  |  |
| 45 | 25.48086955 | -4.280869551 |  |  |  |
| 46 | 24.85383698 | -5.553836978 |  |  |  |
| 47 | 21.11064252 | -1.110642524 |  |  |  |
| 48 | 16.69291303 | -0.092913029 |  |  |  |
| 49 | 5.28282029 | 9.11717971 |  |  |  |
| 50 | 19.16304135 | 0.236958651 |  |  |  |
| 51 | 21.77567707 | -2.075677071 |  |  |  |
| 52 | 25.59487547 | -5.094875473 |  |  |  |
| 53 | 29.53758029 | -4.537580292 |  |  |  |
| 54 | 26.54492483 | -3.144924827 |  |  |  |
| 55 | 20.49311044 | -1.593110444 |  |  |  |
| 56 | 29.98410349 | 5.415896512 |  |  |  |
| 57 | 29.07205611 | -4.372056108 |  |  |  |
| 58 | 30.80114593 | 0.798854068 |  |  |  |
| 59 | 28.03650231 | -4.736502313 |  |  |  |
| 60 | 25.79438584 | -6.194385838 |  |  |  |
| 61 | 22.06069188 | -3.360691877 |  |  |  |
| 62 | 20.83512821 | -4.835128211 |  |  |  |
| 63 | 28.16000873 | -5.960008729 |  |  |  |
| 64 | 25.52837202 | -0.528372019 |  |  |  |
| 65 | 26.90594358 | 6.094056418 |  |  |  |
| 66 | 30.1171104 | -6.617110397 |  |  |  |
| 67 | 24.8253355 | -5.425335497 |  |  |  |
| 68 | 26.85844111 | -4.858441114 |  |  |  |
| 69 | 22.11769484 | -4.717694839 |  |  |  |
| 70 | 26.20290706 | -5.30290706 |  |  |  |
| 71 | 28.16950922 | -3.969509222 |  |  |  |
| 72 | 25.16735326 | -3.467353264 |  |  |  |
| 73 | 29.30956845 | -6.509568447 |  |  |  |
| 74 | 27.39046875 | -3.990468752 |  |  |  |
| 75 | 28.11250626 | -4.012506261 |  |  |  |
| 76 | 26.06039966 | -4.660399657 |  |  |  |
| 77 | 23.18175011 | -3.181750115 |  |  |  |
| 78 | 24.79683402 | -3.996834016 |  |  |  |
| 79 | 22.83023185 | -1.630231854 |  |  |  |
| 80 | 25.90839176 | -5.60839176 |  |  |  |
| 81 | 29.5280798 | -1.528079798 |  |  |  |
| 82 | 27.69448455 | -3.794484545 |  |  |  |
| 83 | 28.16950922 | -3.369509222 |  |  |  |
| 84 | 27.41897023 | -4.518970233 |  |  |  |
| 85 | 25.4143661 | -1.514366096 |  |  |  |
| 86 | 28.3500186 | -1.750018599 |  |  |  |
| 87 | 22.33620619 | 0.16379381 |  |  |  |
| 88 | 26.53542433 | -4.335424334 |  |  |  |
| 89 | 29.32856943 | -5.728569434 |  |  |  |
| 90 | 29.13855956 | -0.438559563 |  |  |  |
| 91 | 26.18390607 | -3.583906073 |  |  |  |
| 92 | 26.76343618 | -4.763436179 |  |  |  |
| 93 | 26.80143815 | -3.901438153 |  |  |  |
| 94 | 28.65403439 | -3.654034393 |  |  |  |
| 95 | 24.49281822 | -3.892818223 |  |  |  |
| 96 | 28.23601268 | 0.163987323 |  |  |  |
| 97 | 23.78028121 | -2.380281208 |  |  |  |
| 98 | 30.5541331 | 8.1458669 |  |  |  |
| 99 | 31.16216469 | 12.63783531 |  |  |  |
| 100 | 28.67303538 | 4.52696462 |  |  |  |
| 101 | 25.60437597 | 1.895624033 |  |  |  |
| 102 | 27.26696234 | -0.766962336 |  |  |  |
| 103 | 24.45481625 | -5.854816249 |  |  |  |
| 104 | 21.78517756 | -2.485177565 |  |  |  |
| 105 | 22.83973235 | -2.739732348 |  |  |  |
| 106 | 18.90652802 | 0.593471977 |  |  |  |
| 107 | 16.82591994 | 2.674080062 |  |  |  |
| 108 | 21.16764548 | -0.767645485 |  |  |  |
| 109 | 22.89673531 | -3.096735309 |  |  |  |
| 110 | 19.78057343 | -0.380573428 |  |  |  |
| 111 | 22.20319928 | -0.503199281 |  |  |  |
| 112 | 24.90133945 | -2.101339445 |  |  |  |
| 113 | 19.15354085 | -0.353540855 |  |  |  |
| 114 | 18.31749742 | 0.382502576 |  |  |  |
| 115 | 24.62582513 | -6.125825133 |  |  |  |
| 116 | 19.58106306 | -1.281063064 |  |  |  |
| 117 | 23.11524666 | -1.91524666 |  |  |  |
| 118 | 24.76833254 | -5.568332536 |  |  |  |
| 119 | 19.95158231 | 0.448417688 |  |  |  |
| 120 | 21.62366917 | -2.323669175 |  |  |  |
| 121 | 20.90163167 | 1.098368334 |  |  |  |
| 122 | 20.9966366 | -0.696636601 |  |  |  |
| 123 | 17.51945597 | 2.980544033 |  |  |  |
| 124 | 10.4130868 | 6.8869132 |  |  |  |
| 125 | 17.85197324 | 0.94802676 |  |  |  |
| 126 | 20.48360995 | 0.91639005 |  |  |  |
| 127 | 8.655495496 | 7.044504504 |  |  |  |
| 128 | 18.22249249 | -2.022492488 |  |  |  |
| 129 | 19.93258133 | -1.932581325 |  |  |  |
| 130 | 17.12993573 | -2.829935731 |  |  |  |
| 131 | 22.58321902 | -3.383219022 |  |  |  |
| 132 | 22.9062358 | -3.306235802 |  |  |  |
| 133 | 23.98929207 | -0.989292066 |  |  |  |
| 134 | 20.27459909 | -1.874599092 |  |  |  |
| 135 | 18.10848657 | -2.508486566 |  |  |  |
| 136 | 18.44100384 | -0.34100384 |  |  |  |
| 137 | 18.4980068 | -1.098006801 |  |  |  |
| 138 | 20.69262081 | -3.592620808 |  |  |  |
| 139 | 14.29878866 | -0.998788657 |  |  |  |
| 140 | 17.01592981 | 0.784070191 |  |  |  |
| 141 | 11.60064849 | 2.399351507 |  |  |  |
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| 468 | 14.29878866 | 4.801211343 |  |  |  |
| 469 | 17.3294461 | 1.770553904 |  |  |  |
| 470 | 20.53111242 | -0.431112418 |  |  |  |
| 471 | 19.07753691 | 0.822463093 |  |  |  |
| 472 | 22.3267057 | -2.726705697 |  |  |  |
| 473 | 20.91113216 | 2.288867841 |  |  |  |
| 474 | 23.47626541 | 6.323734585 |  |  |  |
| 475 | 17.3199456 | -3.519945602 |  |  |  |
| 476 | 11.65765145 | 1.642348546 |  |  |  |
| 477 | 16.80691895 | -0.106918951 |  |  |  |
| 478 | 10.88811148 | 1.111888523 |  |  |  |
| 479 | 17.42445103 | -2.824451031 |  |  |  |
| 480 | 22.09869385 | -0.698693852 |  |  |  |
| 481 | 24.35031082 | -1.35031082 |  |  |  |
| 482 | 27.20045888 | -3.500458881 |  |  |  |
| 483 | 27.89399491 | -2.89399491 |  |  |  |
| 484 | 24.65432661 | -2.854326613 |  |  |  |
| 485 | 21.8801825 | -1.2801825 |  |  |  |
| 486 | 24.50231872 | -3.302318717 |  |  |  |
| 487 | 20.32210156 | -1.22210156 |  |  |  |
| 488 | 23.67577578 | -3.075775779 |  |  |  |
| 489 | 17.39594955 | -2.195949551 |  |  |  |
| 490 | 11.78115787 | -4.78115787 |  |  |  |
| 491 | 6.35637606 | 1.74362394 |  |  |  |
| 492 | 17.38644906 | -3.786449057 |  |  |  |
| 493 | 21.87068201 | -1.770682007 |  |  |  |
| 494 | 23.14374814 | -1.343748141 |  |  |  |
| 495 | 21.64267016 | 2.857329838 |  |  |  |
| 496 | 17.83297225 | 5.267027747 |  |  |  |
| 497 | 14.46979754 | 5.230202459 |  |  |  |
| 498 | 21.15814499 | -2.858144991 |  |  |  |
| 499 | 22.27920323 | -1.079203229 |  |  |  |
| 500 | 20.20809564 | -2.708095638 |  |  |  |
| 501 | 20.93963364 | -4.13963364 |  |  |  |
| 502 | 25.36686363 | -2.966863629 |  |  |  |
| 503 | 25.92739275 | -5.327392747 |  |  |  |
| 504 | 29.19556252 | -5.295562524 |  |  |  |
| 505 | 28.39752107 | -6.397521067 |  |  |  |
| 506 | 27.06745197 | -15.16745197 |  |  |  |

|  |  |
| --- | --- |
| a) | The Regression Summary output: |
|  |  |
|  | *\* The R Square value is 0.54416298, Its Indicating that approximately 54.41% of the variance in the*  *dependent variable can be* ***LSTAT*** *Variable* |
|  | \*The Coefficient for LSTAT is -0.950490354, suggesting a negative relationship LSTAT and dependent variable |
|  | \*The Intercept is 34.5538408, which is the expected mean value of y when all x=0. |
|  | \* The Residual plot shows the residual Scattered around zero across values of LSTAT without any specific pattern,  Indicating the Linear regression might be appropriate for this data. |
|  |  |
| b) | \***Yes,** LSTAT variable significant for the analysis based on the model. |
|  |  |

6) Build a new Regression model including LSTAT and AVG\_ROOM together as Independent variables and AVG\_PRICE as dependent variable. (6 marks) 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? 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.

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| SUMMARY OUTPUT |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| *Regression Statistics* | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Multiple R | 0.799100498 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| R Square | 0.638561606 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Adjusted R Square | 0.637124475 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Standard Error | 5.540257367 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Observations | 506 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |  |  |  |  |  |  |  |
| Regression | 2 | 27276.98621 | 13638.49311 | 444.3308922 | 7.0085E-112 |  |  |  |  |  |  |  |  |  |  |
| Residual | 503 | 15439.3092 | 30.69445169 |  |  |  |  |  |  |  |  |  |  |  |  |
| Total | 505 | 42716.29542 |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |  |  |  |  |  |  |  |
| Intercept | -1.358272812 | 3.17282778 | -0.428095348 | 0.668764941 | -7.591900282 | 4.875354658 | -7.591900282 | 4.875354658 |  |  |  |  |  |  |  |
| LSTAT | -0.642358334 | 0.043731465 | -14.68869925 | 6.66937E-41 | -0.728277167 | -0.556439501 | -0.728277167 | -0.556439501 |  |  |  |  |  |  |  |
| AVG\_ROOM | 5.094787984 | 0.4444655 | 11.46272991 | 3.47226E-27 | 4.221550436 | 5.968025533 | 4.221550436 | 5.968025533 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | a) | \* The Regression equation is given as: | | |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **AVG\_PRICE = -1.358272812 + (5.094787984 \times {AVG\_ROOM}) –**  **(0.642358334 \times {L-STAT})** | | | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Substituting the values of AVG\_ROOM as 7 and L-STAT as 20, we get: | | | | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | AVG\_PRICE = -1.358272812 + (5.094787984 \times 7) - (0.642358334 \  times 20) | | | | | |  |  |  |  |  |  |  |  |
|  |  | AVG\_PRICE = -1.358272812 + 35.663815888 -12.84716668 | | | |  |  |  |  |  |  |  |  |  |  |
|  |  | AVG\_PRICE = 21.458376396 | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Average price =$21.458 | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | b) | \*Since the Adjusted R-Square value for the current model (0.637124475)  is higher than that for the previous model (0.543241826). | | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | \*Comparing this to the company's quote of $30,000, it appears that  the company is overcharging. Please note that this is a simple analysis and  actual real estate prices. | | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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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 of each independent variable with respect to AVG\_PRICE.

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| SUMMARY OUTPUT |  |  |  |  |  |
|  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |
| Multiple R | 0.832978824 |  |  |  |  |
| R Square | 0.69385372 |  |  |  |  |
| Adjusted R Square | 0.688298647 |  |  |  |  |
| Standard Error | 5.1347635 |  |  |  |  |
| Observations | 506 |  |  |  |  |
|  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 9 | 29638.8605 | 3293.206722 | 124.9045049 | 1.9328E-121 |
| Residual | 496 | 13077.43492 | 26.3657962 |  |  |
| Total | 505 | 42716.29542 |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 29.24131526 | 4.817125596 | 6.070282926 | 2.53978E-09 | 19.77682784 | 38.70580267 | 19.77682784 | 38.70580267 |
| CRIME\_RATE | 0.048725141 | 0.078418647 | 0.621346369 | 0.534657201 | -0.105348544 | 0.202798827 | -0.105348544 | 0.202798827 |
| AGE | 0.032770689 | 0.013097814 | 2.501996817 | 0.012670437 | 0.00703665 | 0.058504728 | 0.00703665 | 0.058504728 |
| INDUS | 0.130551399 | 0.063117334 | 2.068392165 | 0.03912086 | 0.006541094 | 0.254561704 | 0.006541094 | 0.254561704 |
| NOX | -10.3211828 | 3.894036256 | -2.650510195 | 0.008293859 | -17.97202279 | -2.670342809 | -17.97202279 | -2.670342809 |
| DISTANCE | 0.261093575 | 0.067947067 | 3.842602576 | 0.000137546 | 0.127594012 | 0.394593138 | 0.127594012 | 0.394593138 |
| TAX | -0.01440119 | 0.003905158 | -3.687736063 | 0.000251247 | -0.022073881 | -0.0067285 | -0.022073881 | -0.0067285 |
| PTRATIO | -1.074305348 | 0.133601722 | -8.041104061 | 6.58642E-15 | -1.336800438 | -0.811810259 | -1.336800438 | -0.811810259 |
| AVG\_ROOM | 4.125409152 | 0.442758999 | 9.317504929 | 3.89287E-19 | 3.255494742 | 4.995323561 | 3.255494742 | 4.995323561 |
| LSTAT | -0.603486589 | 0.053081161 | -11.36912937 | 8.91071E-27 | -0.70777824 | -0.499194938 | -0.70777824 | -0.499194938 |

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| The summary of a regression analysis, where AVG\_PRICE is likely the dependent variable being predicted by  various independent variables. | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*Adjusted R Square (0.688298647)**: This value indicates that approximately 68.83% of the variability in AVG\_PRICE  can be explained by the included independent variables. It's an adjusted measure that takes into account  the number of predictors in the model to provide a more accurate estimate. | | | | | | | | | | | | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*Intercept (29.341231526):** This is the expected value of AVG\_PRICE when all independent variables are zero. | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Here are each of the coefficients for the independent variables and their significance: | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*CRIME\_RATE (0.048725141):** For each unit increase in CRIME\_RATE, AVG\_PRICE increases by  approximately 0.0487 units, holding all else constant. The p-value is significant at less than 0.05,  indicating a statistically significant relationship. | | | | | | | | | | | | | | | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*AGE (0.032770689):** Each unit increase in AGE is associated with an approximate 0.0328 unit increase in  AVG\_PRICE, holding other factors constant; it's statistically significant with p-value less than 0.05. | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*INDUS (0.130551999)**: INDUS has a positive coefficient but isn't statistically significant as its p-value exceeds 0.05;  hence we can't confidently claim an effect on AVG\_PRICE. | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*NOX (-10.32118278):** A unit increase in NOX is associated with about a -10.32 decrease in AVG\_PRICE;  it’s statistically significant given its low p-value. | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*DISTANCE (0.261093575)**: These values aren’t visible so I need to see them to interpret their effects on  AVG\_PRICE accurately. | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*TAX (-0.):** The coefficient isn’t fully visible but assuming it’s negative, it suggests that as TAX increases,  AVG\_PRICE decreases; it’s also statistically significant due to its low p-value. | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*PTRATIO(-1.):** Again not fully visible but if negative, indicates that higher PTRATIO leads to lower  AVG\_PRICE and is statistically significant given its low p-value. | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*AVG\_ROOM(4.125409151)**: Indicates that for each additional room,  there’s an approximate increase of 4 units in AVG\_PRICE; highly significant with very low p-value. | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **\*LSTAT(-0.):** The coefficient not fully visible but assuming it’s negative value, it suggest that as LSTAT increases,  AVG\_PRICE decreases; it’s also statistically significant due to its low p-value. | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |

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: (8 marks) 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.

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| SUMMARY OUTPUT |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.832835773 |  |  |  |  |  |  |  |
| R Square | 0.693615426 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.688683682 |  |  |  |  |  |  |  |
| Standard Error | 5.131591113 |  |  |  |  |  |  |  |
| Observations | 506 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 8 | 29628.68142 | 3703.585178 | 140.6430411 | 1.911E-122 |  |  |  |
| Residual | 497 | 13087.61399 | 26.33322735 |  |  |  |  |  |
| Total | 505 | 42716.29542 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 29.42847349 | 4.804728624 | 6.124898157 | 1.84597E-09 | 19.98838959 | 38.8685574 | 19.98838959 | 38.8685574 |
| 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 |
| NOX | -10.27270508 | 3.890849222 | -2.640221837 | 0.008545718 | -17.9172457 | -2.628164466 | -17.9172457 | -2.628164466 |
| DISTANCE | 0.261506423 | 0.067901841 | 3.851242024 | 0.000132887 | 0.128096375 | 0.394916471 | 0.128096375 | 0.394916471 |
| TAX | -0.014452345 | 0.003901877 | -3.703946406 | 0.000236072 | -0.022118553 | -0.006786137 | -0.022118553 | -0.006786137 |
| PTRATIO | -1.071702473 | 0.133453529 | -8.030529271 | 7.08251E-15 | -1.333905109 | -0.809499836 | -1.333905109 | -0.809499836 |
| AVG\_ROOM | 4.125468959 | 0.44248544 | 9.323400461 | 3.68969E-19 | 3.256096304 | 4.994841615 | 3.256096304 | 4.994841615 |
| LSTAT | -0.605159282 | 0.0529801 | -11.42238841 | 5.41844E-27 | -0.70925186 | -0.501066704 | -0.70925186 | -0.501066704 |

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| a) | The Regression analysis. | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | **\*Regression Statistics:** The model has a Multiple R (correlation coefficient) of 0.832,  indicating a strong positive relationship between the predictors and the response variable.  The R Square value of 0.6936 suggests that approximately 69.36% of the variation in the response variable  can be explained by the predictors. The Adjusted R Square value of 0.6888 takes into account the number of  predictors and is a more accurate measure of the goodness of fit. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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|  | **\*ANOVA**: The F statistic is 140.634 with a very low p-value (1.911E-122), indicating that the regression model predicts the response variable significantly better than the mean of the response variable. | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | **\*Coefficients**: The coefficients table provides the estimates for each predictor. For instance,  the coefficient of AGE is 0.0329, meaning for each unit increase in AGE, the response variable increases  by 0.0329 units, holding all other predictors constant. The p-values in this table can be used to test the  hypothesis that each coefficient is different from zero. A small p-value (<= 0.05) indicates that we can reject  the null hypothesis. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| b) | The Adjusted R-square value for this model is **0.688368682**, the previous model's Adjusted R-square value is **0.688298647**. | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | Since a higher Adjusted R-square value indicates a better fit of the model, this model performs marginally better according to the Adjusted R-square value. | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| c) | The coefficients in Ascending order: | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | PTRATIO | -1.071702476 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | LSTAT | -0.605159282 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | TAX | -0.014254345 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | INDUS | 0.130710007 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | AGE | 0.032932496 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | DISTANCE | 0.261506423 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | AVG\_ROOM | 4.125468959 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| d) | The regression equation: | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | {AVG\_PRICE} = 29.42847349 + 0.239324996 {AGE} + 0.130710007 {INDUS} - 0.127070508 {NOX} + 0.261506423 {DISTANCE} - 0.01445345 {TAX} - 0.171042773 {PTRATIO} + 4.125468959 {AVG\_ROOM} - 0.605159282 {LSTAT} | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | Where: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | AVG\_PRICE is the dependent variable | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | AGE, INDUS, NOX, DISTANCE, TAX, PTRATIO, AVG\_ROOM, and LSTAT are the independent variables. | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |