# HW_8-9_Gupta_S

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1. Describe your substantive interest and the general questions(s) you would like to answer (eg, "Does more education cause people to become more liberal?"). Be sure to frame it in a such a way that you are proposing a hypothesis (or multiple hypotheses) that might be either confirmed or disproven by the results of your analysis.

Ans:

This dataset includes data for used GM cars which can be used to determine the car value based on a variety of characteristics such as mileage, make, model, engine size, interior style, and cruise control.

I would like to hypothesize : ""Are cars with lower mileage worth more?"

2. Describe the data set you have found, including its source, its contents, and why it was collected originally.

Ans:

General Data Description: This dataset includes data for used GM cars which can be used to determine the car value based on a variety of characteristics such as mileage, make, model, engine size, interior style, and cruise control.

Source: The data is collected from Kelly Blue book which is a California based vehicle valuation and automotive research company recognized by both consumers and the automotive industry.

Contents: VARIABLE DESCRIPTIONS: Price: suggested retail price of the used 2005 GM car in excellent condition. The condition of a car can greatly affect price. All cars in this data set were less than one year old when priced and considered to be in excellent condition. Mileage: number of miles the car has been driven Make: manufacturer of the car such as Saturn, Pontiac, and Chevrolet Type: body type such as sedan, coupe, etc. Cylinder: number of cylinders in the engine Doors: number of doors
Cruise: indicator variable representing whether the car has cruise control (1 = cruise) Sound: indicator variable representing whether the car has upgraded speakers (1 = upgraded) Leather: indicator variable representing whether the car has leather seats (1 = leather)

The dataset has 9 variables and 804 rows of records. The data is collected so that a multivariate regression model can be built to determine car values based on various characteristics as mentioned. The dataset can also be used to visualize residual plots to check for the assumptions of linear regression as well as explore techniques for variable selection.

3. What is your dependent variable? Why are you interested in explaining it? What do you hypothesize are the major factors that influence or cause it?

Ans:

My dependent variable is the price of the used cars. I want to check if a car having higher number of cylinder will fetch more price for sales. I hypothesize that Miles the car has run (mileage), Liter, Make could be the major factors that can infleunce the car prices.

4. What are your independent variables, and why have you chosen these? Prior to running your regression, what effects do you expect them to have on the dependent variable? Which of these variables do you think affect other of the independent variables, and how might that affect your final results?

Ans:

```r
# Loading the dataset
CarPrice_Estimate <- data.frame(read.csv("Kuiper.csv", sep = ",", header = T, stringsAsFactors = F))

df<-CarPrice_Estimate[,-(10:21)]
na.omit(df)
```

```
##         Price Mileage      Make        Type Cylinder Doors Cruise Sound
## 1   17314.103    8221     Buick       Sedan        6     4      1     1
## 2   17542.036    9135     Buick       Sedan        6     4      1     1
## 3   16218.848   13196     Buick       Sedan        6     4      1     1
## 4   16336.913   16342     Buick       Sedan        6     4      1     0
## 5   16339.170   19832     Buick       Sedan        6     4      1     0
## 6   15709.053   22236     Buick       Sedan        6     4      1     1
## 7   15230.003   22576     Buick       Sedan        6     4      1     1
## 8   15048.042   22964     Buick       Sedan        6     4      1     1
## 9   14862.094   24021     Buick       Sedan        6     4      1     0
## 10  15295.018   27325     Buick       Sedan        6     4      1     1
## 11  21335.852   10237     Buick       Sedan        6     4      1     0
## 12  20538.088   15066     Buick       Sedan        6     4      1     1
## 13  20512.094   16633     Buick       Sedan        6     4      1     1
## 14  19924.159   19800     Buick       Sedan        6     4      1     1
## 15  19774.249   23359     Buick       Sedan        6     4      1     1
## 16  19344.166   23765     Buick       Sedan        6     4      1     1
## 17  19105.130   24008     Buick       Sedan        6     4      1     0
## 18  18543.427   26034     Buick       Sedan        6     4      1     1
## 19  17808.199   32896     Buick       Sedan        6     4      1     1
## 20  17968.838   34665     Buick       Sedan        6     4      1     1
## 21  22358.878    8970     Buick       Sedan        6     4      1     1
## 22  23785.923   10577     Buick       Sedan        6     4      1     1
## 23  22926.090   14363     Buick       Sedan        6     4      1     1
## 24  21895.759   16508     Buick       Sedan        6     4      1     0
## 25  21273.062   18908     Buick       Sedan        6     4      1     0
## 26  21460.014   19467     Buick       Sedan        6     4      1     0
## 27  21183.124   21394     Buick       Sedan        6     4      1     0
## 28  20406.100   22596     Buick       Sedan        6     4      1     0
## 29  21058.140   24469     Buick       Sedan        6     4      1     1
## 30  19556.899   25245     Buick       Sedan        6     4      1     0
## 31  23447.687   15755     Buick       Sedan        6     4      1     1
## 32  23547.239   16235     Buick       Sedan        6     4      1     1
## 33  23016.008   18147     Buick       Sedan        6     4      1     1
## 34  22230.028   22102     Buick       Sedan        6     4      1     0
## 35  22625.074   23612     Buick       Sedan        6     4      1     0
## 36  21799.172   24439     Buick       Sedan        6     4      1     0
## 37  21341.257   25212     Buick       Sedan        6     4      1     1
## 38  21683.031   26779     Buick       Sedan        6     4      1     1
## 39  20986.016   27096     Buick       Sedan        6     4      1     0
## 40  20902.104   29649     Buick       Sedan        6     4      1     1
## 41  20698.077    2992     Buick       Sedan        6     4      1     0
## 42  20099.257   10036     Buick       Sedan        6     4      1     1
## 43  18145.126   18339     Buick       Sedan        6     4      1     1
## 44  17944.857   19592     Buick       Sedan        6     4      1     0
## 45  19027.862   21797     Buick       Sedan        6     4      1     0
## 46  18348.899   23852     Buick       Sedan        6     4      1     1
## 47  17750.885   25040     Buick       Sedan        6     4      1     1
```

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## 48  17772.970   25052     Buick       Sedan        6     4      1     1
## 49  17394.021   25464     Buick       Sedan        6     4      1     1
## 50  17645.745   27830     Buick       Sedan        6     4      1     1
## 51  21908.367   17353     Buick       Sedan        6     4      1     0
## 52  21956.343   17787     Buick       Sedan        6     4      1     1
## 53  21646.117   19562     Buick       Sedan        6     4      1     1
## 54  21575.457   20137     Buick       Sedan        6     4      1     1
## 55  20952.218   20158     Buick       Sedan        6     4      1     1
## 56  21562.048   23767     Buick       Sedan        6     4      1     0
## 57  19981.128   24323     Buick       Sedan        6     4      1     1
## 58  19425.849   27839     Buick       Sedan        6     4      1     1
## 59  19191.990   29187     Buick       Sedan        6     4      1     1
## 60  19641.742   31324     Buick       Sedan        6     4      1     1
## 61  25589.983    2308     Buick       Sedan        6     4      1     1
## 62  25098.629   10014     Buick       Sedan        6     4      1     1
## 63  23420.707   18910     Buick       Sedan        6     4      1     0
## 64  22661.048   20105     Buick       Sedan        6     4      1     0
## 65  23493.082   20453     Buick       Sedan        6     4      1     1
## 66  22435.203   22287     Buick       Sedan        6     4      1     1
## 67  21878.120   23237     Buick       Sedan        6     4      1     1
## 68  23077.566   23798     Buick       Sedan        6     4      1     0
## 69  21698.015   25489     Buick       Sedan        6     4      1     1
## 70  21831.823   25564     Buick       Sedan        6     4      1     1
## 71  26831.194    4695     Buick       Sedan        6     4      1     1
## 72  26060.335    9795     Buick       Sedan        6     4      1     1
## 73  26781.815   12052     Buick       Sedan        6     4      1     1
## 74  26302.074   13050     Buick       Sedan        6     4      1     1
## 75  26190.271   17335     Buick       Sedan        6     4      1     0
## 76  25508.211   17480     Buick       Sedan        6     4      1     1
## 77  23348.017   24027     Buick       Sedan        6     4      1     0
## 78  23406.690   25387     Buick       Sedan        6     4      1     0
## 79  23159.544   25869     Buick       Sedan        6     4      1     0
## 80  21536.742   37128     Buick       Sedan        6     4      1     1
## 81  51154.047    2202  Cadillac       Sedan        8     4      1     1
## 82  49248.159    6685  Cadillac       Sedan        8     4      1     0
## 83  46747.673   15343  Cadillac       Sedan        8     4      1     1
## 84  44130.617   21341  Cadillac       Sedan        8     4      1     0
## 85  44084.914   21367  Cadillac       Sedan        8     4      1     1
## 86  43892.468   23371  Cadillac       Sedan        8     4      1     0
## 87  44300.640   23751  Cadillac       Sedan        8     4      1     0
## 88  42677.601   24052  Cadillac       Sedan        8     4      1     0
## 89  43374.052   25199  Cadillac       Sedan        8     4      1     1
## 90  40619.072   30082  Cadillac       Sedan        8     4      1     1
## 91  33417.965    6598  Cadillac       Sedan        6     4      1     1
## 92  30957.081   10625  Cadillac       Sedan        6     4      1     1
## 93  31431.130   11013  Cadillac       Sedan        6     4      1     1
## 94  30781.516   14937  Cadillac       Sedan        6     4      1     1
## 95  30646.438   17094  Cadillac       Sedan        6     4      1     1
## 96  30792.149   17870  Cadillac       Sedan        6     4      1     1
## 97  30392.750   18449  Cadillac       Sedan        6     4      1     1
## 98  28817.082   21039  Cadillac       Sedan        6     4      1     0
## 99  29275.209   21056  Cadillac       Sedan        6     4      1     1
## 100 28040.129   27484  Cadillac       Sedan        6     4      1     1
## 101 39801.551   14095  Cadillac       Sedan        8     4      1     0
```

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## 102 40335.737   14743  Cadillac       Sedan        8     4      1     0
## 103 39307.009   16041  Cadillac       Sedan        8     4      1     0
## 104 38600.240   17138  Cadillac       Sedan        8     4      1     0
## 105 38445.897   18661  Cadillac       Sedan        8     4      1     0
## 106 36077.796   21966  Cadillac       Sedan        8     4      1     0
## 107 35866.583   24415  Cadillac       Sedan        8     4      1     1
## 108 35338.654   25163  Cadillac       Sedan        8     4      1     0
## 109 36154.304   25339  Cadillac       Sedan        8     4      1     1
## 110 34685.663   25421  Cadillac       Sedan        8     4      1     0
## 111 42820.329    5499  Cadillac       Sedan        8     4      1     0
## 112 41378.048    8125  Cadillac       Sedan        8     4      1     0
## 113 40856.391   12791  Cadillac       Sedan        8     4      1     1
## 114 41419.037   14452  Cadillac       Sedan        8     4      1     0
## 115 37510.254   21593  Cadillac       Sedan        8     4      1     0
## 116 37215.169   22211  Cadillac       Sedan        8     4      1     0
## 117 36332.895   25153  Cadillac       Sedan        8     4      1     0
## 118 36245.158   26250  Cadillac       Sedan        8     4      1     1
## 119 32954.141   36074  Cadillac       Sedan        8     4      1     0
## 120 32537.187   41829  Cadillac       Sedan        8     4      1     1
## 121 35715.769    6447  Cadillac       Sedan        8     4      1     0
## 122 35651.680   10555  Cadillac       Sedan        8     4      1     1
## 123 35129.341   11975  Cadillac       Sedan        8     4      1     1
## 124 35165.759   13449  Cadillac       Sedan        8     4      1     1
## 125 32501.245   17508  Cadillac       Sedan        8     4      1     0
## 126 33220.028   18661  Cadillac       Sedan        8     4      1     0
## 127 32509.478   20910  Cadillac       Sedan        8     4      1     0
## 128 31132.213   23124  Cadillac       Sedan        8     4      1     1
## 129 31181.715   26222  Cadillac       Sedan        8     4      1     0
## 130 31059.181   27544  Cadillac       Sedan        8     4      1     1
## 131 42741.524    2846  Cadillac       Sedan        6     4      1     0
## 132 40966.607    7476  Cadillac       Sedan        6     4      1     1
## 133 38795.379   13973  Cadillac       Sedan        6     4      1     1
## 134 38297.463   16754  Cadillac       Sedan        6     4      1     0
## 135 37192.896   19100  Cadillac       Sedan        6     4      1     0
## 136 36210.123   21778  Cadillac       Sedan        6     4      1     0
## 137 36633.634   22042  Cadillac       Sedan        6     4      1     1
## 138 35895.499   23056  Cadillac       Sedan        6     4      1     1
## 139 34974.378   25796  Cadillac       Sedan        6     4      1     1
## 140 32038.340   35326  Cadillac       Sedan        6     4      1     1
## 141 48310.330     788  Cadillac       Sedan        8     4      1     0
## 142 48365.981    2616  Cadillac       Sedan        8     4      1     1
## 143 45061.952   13829  Cadillac       Sedan        8     4      1     1
## 144 44205.876   15104  Cadillac       Sedan        8     4      1     0
## 145 42377.955   18581  Cadillac       Sedan        8     4      1     0
## 146 41671.583   20575  Cadillac       Sedan        8     4      1     0
## 147 41516.430   23861  Cadillac       Sedan        8     4      1     1
## 148 41053.482   25717  Cadillac       Sedan        8     4      1     1
## 149 38208.501   31303  Cadillac       Sedan        8     4      1     1
## 150 39072.392   31587  Cadillac       Sedan        8     4      1     0
## 151 70755.467     583  Cadillac Convertible        8     2      1     1
## 152 68566.187    6420  Cadillac Convertible        8     2      1     1
## 153 69133.732    7892  Cadillac Convertible        8     2      1     1
## 154 66374.307   12021  Cadillac Convertible        8     2      1     1
## 155 65281.481   15600  Cadillac Convertible        8     2      1     1
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## 156 63913.117   18200  Cadillac Convertible        8     2      1     1
## 157 60567.549   23193  Cadillac Convertible        8     2      1     1
## 158 57154.443   29260  Cadillac Convertible        8     2      1     1
## 159 55639.088   31805  Cadillac Convertible        8     2      1     0
## 160 52001.994   42691  Cadillac Convertible        8     2      1     1
## 161 12146.188   10011 Chevrolet   Hatchback        4     4      0     0
## 162 12163.820   12101 Chevrolet   Hatchback        4     4      0     0
## 163 11472.023   19699 Chevrolet   Hatchback        4     4      0     0
## 164 11017.169   20100 Chevrolet   Hatchback        4     4      0     1
## 165 11096.857   20334 Chevrolet   Hatchback        4     4      1     0
## 166 10386.040   22225 Chevrolet   Hatchback        4     4      0     0
## 167 11137.046   22484 Chevrolet   Hatchback        4     4      0     1
## 168 11045.109   24568 Chevrolet   Hatchback        4     4      1     0
## 169 10777.053   27906 Chevrolet   Hatchback        4     4      0     0
## 170  9928.188   29680 Chevrolet   Hatchback        4     4      0     0
## 171 12649.111    3629 Chevrolet       Sedan        4     4      0     1
## 172 12314.591    4142 Chevrolet       Sedan        4     4      0     1
## 173 11318.008   11156 Chevrolet       Sedan        4     4      0     1
## 174 12409.949   11981 Chevrolet       Sedan        4     4      1     1
## 175 11555.267   13404 Chevrolet       Sedan        4     4      1     1
## 176 11700.111   15253 Chevrolet       Sedan        4     4      1     0
## 177 11215.019   19945 Chevrolet       Sedan        4     4      0     0
## 178 10144.952   23963 Chevrolet       Sedan        4     4      1     1
## 179 10491.075   30948 Chevrolet       Sedan        4     4      0     1
## 180  9954.054   37345 Chevrolet       Sedan        4     4      0     1
## 181 11031.130   20156 Chevrolet   Hatchback        4     4      0     1
## 182 11343.054   20186 Chevrolet   Hatchback        4     4      1     1
## 183 11391.214   21421 Chevrolet   Hatchback        4     4      0     1
## 184 11247.863   21427 Chevrolet   Hatchback        4     4      1     1
## 185 10921.945   23119 Chevrolet   Hatchback        4     4      0     1
## 186 11179.954   23121 Chevrolet   Hatchback        4     4      0     1
## 187 11394.886   25107 Chevrolet   Hatchback        4     4      0     1
## 188 11070.061   25476 Chevrolet   Hatchback        4     4      0     1
## 189 11013.871   25746 Chevrolet   Hatchback        4     4      1     1
## 190 11115.014   30056 Chevrolet   Hatchback        4     4      1     1
## 191 11918.456    7278 Chevrolet       Sedan        4     4      0     0
## 192 12408.806   10213 Chevrolet       Sedan        4     4      0     0
## 193 11302.903   14627 Chevrolet       Sedan        4     4      0     1
## 194 11615.021   19014 Chevrolet       Sedan        4     4      0     1
## 195 10805.130   21013 Chevrolet       Sedan        4     4      1     1
## 196 11169.918   22380 Chevrolet       Sedan        4     4      0     1
## 197 10770.107   25065 Chevrolet       Sedan        4     4      0     1
## 198 10872.014   25869 Chevrolet       Sedan        4     4      0     0
## 199 10921.945   27776 Chevrolet       Sedan        4     4      1     0
## 200  9919.048   34621 Chevrolet       Sedan        4     4      0     1
## 201 10813.344     266 Chevrolet   Hatchback        4     4      1     0
## 202 11167.861    4716 Chevrolet   Hatchback        4     4      1     1
## 203 10897.077    6699 Chevrolet   Hatchback        4     4      0     1
## 204 10106.016   14200 Chevrolet   Hatchback        4     4      1     0
## 205 10354.044   14521 Chevrolet   Hatchback        4     4      0     1
## 206 10287.977   16521 Chevrolet   Hatchback        4     4      1     1
## 207  9720.979   20836 Chevrolet   Hatchback        4     4      1     1
## 208  9506.048   22169 Chevrolet   Hatchback        4     4      0     0
## 209  9789.038   22986 Chevrolet   Hatchback        4     4      0     1
```

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## 210  9220.830   29992 Chevrolet   Hatchback        4     4      1     0
## 211 10971.096    7091 Chevrolet       Sedan        4     4      1     0
## 212 10315.018   14438 Chevrolet       Sedan        4     4      0     0
## 213  9654.060   19183 Chevrolet       Sedan        4     4      0     0
## 214  9563.789   19273 Chevrolet       Sedan        4     4      1     1
## 215  9665.849   19565 Chevrolet       Sedan        4     4      0     1
## 216  9482.219   24842 Chevrolet       Sedan        4     4      1     0
## 217  8638.931   25216 Chevrolet       Sedan        4     4      0     0
## 218  9041.906   26191 Chevrolet       Sedan        4     4      0     0
## 219  8870.947   32914 Chevrolet       Sedan        4     4      1     1
## 220  8768.999   35299 Chevrolet       Sedan        4     4      0     0
## 221 13007.984    7372 Chevrolet       Coupe        4     2      1     1
## 222 13041.874   13607 Chevrolet       Coupe        4     2      0     1
## 223 12045.921   19136 Chevrolet       Coupe        4     2      0     1
## 224 12469.528   19712 Chevrolet       Coupe        4     2      0     1
## 225 11539.846   22405 Chevrolet       Coupe        4     2      0     1
## 226 11726.003   23103 Chevrolet       Coupe        4     2      0     1
## 227 12207.873   23512 Chevrolet       Coupe        4     2      1     1
## 228 11203.146   27364 Chevrolet       Coupe        4     2      1     1
## 229 10788.970   31436 Chevrolet       Coupe        4     2      1     1
## 230 11149.618   34447 Chevrolet       Coupe        4     2      1     1
## 231 14584.448    1160 Chevrolet       Coupe        4     2      1     1
## 232 13681.698   10210 Chevrolet       Coupe        4     2      1     1
## 233 13446.213   17741 Chevrolet       Coupe        4     2      0     1
## 234 12327.642   19347 Chevrolet       Coupe        4     2      0     1
## 235 12274.958   19612 Chevrolet       Coupe        4     2      1     1
## 236 12630.775   22571 Chevrolet       Coupe        4     2      1     1
## 237 12425.389   22771 Chevrolet       Coupe        4     2      0     1
## 238 12319.696   24568 Chevrolet       Coupe        4     2      1     1
## 239 12549.892   25816 Chevrolet       Coupe        4     2      0     1
## 240 12234.888   30297 Chevrolet       Coupe        4     2      1     1
## 241 14894.983    2464 Chevrolet       Sedan        4     4      0     1
## 242 14198.092   11322 Chevrolet       Sedan        4     4      1     1
## 243 14678.105   11488 Chevrolet       Sedan        4     4      1     1
## 244 13167.702   14630 Chevrolet       Sedan        4     4      0     1
## 245 13471.005   18910 Chevrolet       Sedan        4     4      1     1
## 246 12573.900   25048 Chevrolet       Sedan        4     4      1     1
## 247 12383.403   25069 Chevrolet       Sedan        4     4      1     1
## 248 13230.919   25862 Chevrolet       Sedan        4     4      0     1
## 249 11080.516   36855 Chevrolet       Sedan        4     4      0     1
## 250 11328.959   39946 Chevrolet       Sedan        4     4      1     1
## 251 15053.934    4652 Chevrolet       Coupe        4     2      1     1
## 252 14397.928    5189 Chevrolet       Coupe        4     2      0     1
## 253 14642.324    6224 Chevrolet       Coupe        4     2      0     1
## 254 13464.803   14231 Chevrolet       Coupe        4     2      1     1
## 255 13678.863   17971 Chevrolet       Coupe        4     2      1     1
## 256 12507.485   19715 Chevrolet       Coupe        4     2      1     1
## 257 13141.048   19898 Chevrolet       Coupe        4     2      1     1
## 258 13594.086   20682 Chevrolet       Coupe        4     2      1     1
## 259 12733.858   21386 Chevrolet       Coupe        4     2      1     1
## 260 12230.100   28408 Chevrolet       Coupe        4     2      0     1
## 261 14222.305    8427 Chevrolet       Sedan        4     4      0     1
## 262 14266.913    8615 Chevrolet       Sedan        4     4      0     1
## 263 14255.748   16958 Chevrolet       Sedan        4     4      0     1
```

```
## 264 13762.901   18040 Chevrolet       Sedan        4     4      1     1
## 265 14275.128   18533 Chevrolet       Sedan        4     4      1     1
## 266 13688.000   18766 Chevrolet       Sedan        4     4      1     1
## 267 13308.834   20043 Chevrolet       Sedan        4     4      0     1
## 268 14145.881   20512 Chevrolet       Sedan        4     4      1     1
## 269 12944.939   21684 Chevrolet       Sedan        4     4      0     1
## 270 12846.062   27560 Chevrolet       Sedan        4     4      1     1
## 271 14061.123    4922 Chevrolet       Sedan        4     4      0     1
## 272 13072.842   14311 Chevrolet       Sedan        4     4      0     1
## 273 11699.034   19816 Chevrolet       Sedan        4     4      1     1
## 274 12257.164   21492 Chevrolet       Sedan        4     4      1     1
## 275 11574.174   21525 Chevrolet       Sedan        4     4      0     1
## 276 11539.049   24163 Chevrolet       Sedan        4     4      0     1
## 277 12243.061   25014 Chevrolet       Sedan        4     4      1     1
## 278 11671.858   25727 Chevrolet       Sedan        4     4      1     1
## 279 11464.629   29410 Chevrolet       Sedan        4     4      1     1
## 280 10546.783   38866 Chevrolet       Sedan        4     4      1     1
## 281 15553.209    7695 Chevrolet       Sedan        4     4      0     1
## 282 15047.003   12305 Chevrolet       Sedan        4     4      1     1
## 283 13540.042   17343 Chevrolet       Sedan        4     4      0     1
## 284 14077.969   17445 Chevrolet       Sedan        4     4      0     1
## 285 12981.952   20309 Chevrolet       Sedan        4     4      1     1
## 286 13436.000   20530 Chevrolet       Sedan        4     4      0     1
## 287 13161.943   21145 Chevrolet       Sedan        4     4      1     1
## 288 14220.013   23069 Chevrolet       Sedan        4     4      1     1
## 289 12379.126   31199 Chevrolet       Sedan        4     4      1     1
## 290 11581.905   36566 Chevrolet       Sedan        4     4      0     1
## 291 14023.939   13776 Chevrolet       Coupe        4     2      0     1
## 292 12810.911   19461 Chevrolet       Coupe        4     2      1     1
## 293 13135.905   21796 Chevrolet       Coupe        4     2      1     1
## 294 13106.900   21910 Chevrolet       Coupe        4     2      0     1
## 295 12845.174   22382 Chevrolet       Coupe        4     2      1     1
## 296 12570.137   22479 Chevrolet       Coupe        4     2      0     1
## 297 12897.930   23200 Chevrolet       Coupe        4     2      1     1
## 298 11961.620   27394 Chevrolet       Coupe        4     2      1     1
## 299 12706.911   27521 Chevrolet       Coupe        4     2      1     1
## 300 12487.054   28492 Chevrolet       Coupe        4     2      0     1
## 301 15635.796    1169 Chevrolet       Coupe        4     2      0     1
## 302 15747.804    6048 Chevrolet       Coupe        4     2      0     1
## 303 14619.079   15768 Chevrolet       Coupe        4     2      1     1
## 304 14185.022   20374 Chevrolet       Coupe        4     2      0     1
## 305 13699.036   25845 Chevrolet       Coupe        4     2      1     1
## 306 13310.060   26143 Chevrolet       Coupe        4     2      1     1
## 307 13530.069   27249 Chevrolet       Coupe        4     2      1     1
## 308 13019.071   27942 Chevrolet       Coupe        4     2      1     1
## 309 12684.986   29891 Chevrolet       Coupe        4     2      1     1
## 310 12553.071   32844 Chevrolet       Coupe        4     2      1     1
## 311 14997.884    8880 Chevrolet       Sedan        4     4      0     1
## 312 14847.044   12980 Chevrolet       Sedan        4     4      0     1
## 313 15128.992   13828 Chevrolet       Sedan        4     4      1     1
## 314 15000.993   14504 Chevrolet       Sedan        4     4      0     1
## 315 14593.854   18790 Chevrolet       Sedan        4     4      0     1
## 316 14304.741   21128 Chevrolet       Sedan        4     4      0     1
## 317 13688.946   21611 Chevrolet       Sedan        4     4      1     1
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## 318 13744.850   23748 Chevrolet       Sedan        4     4      0     1
## 319 13545.031   27431 Chevrolet       Sedan        4     4      0     1
## 320 12741.190   34815 Chevrolet       Sedan        4     4      0     1
## 321 16116.844     865 Chevrolet       Sedan        4     4      1     1
## 322 16428.579    9882 Chevrolet       Sedan        4     4      0     1
## 323 15084.815   14824 Chevrolet       Sedan        4     4      1     1
## 324 15163.170   17158 Chevrolet       Sedan        4     4      1     1
## 325 14897.041   18210 Chevrolet       Sedan        4     4      1     1
## 326 14508.750   18910 Chevrolet       Sedan        4     4      0     1
## 327 14418.165   19818 Chevrolet       Sedan        4     4      0     1
## 328 14191.882   21181 Chevrolet       Sedan        4     4      1     1
## 329 14401.907   21527 Chevrolet       Sedan        4     4      0     1
## 330 14175.879   21627 Chevrolet       Sedan        4     4      0     1
## 331 14429.790    6114 Chevrolet       Sedan        4     4      1     1
## 332 14696.029    6709 Chevrolet       Sedan        4     4      1     1
## 333 14582.769    7115 Chevrolet       Sedan        4     4      1     1
## 334 14194.824    9561 Chevrolet       Sedan        4     4      0     1
## 335 14072.135   15233 Chevrolet       Sedan        4     4      0     1
## 336 13994.906   17270 Chevrolet       Sedan        4     4      0     1
## 337 13830.249   17594 Chevrolet       Sedan        4     4      0     1
## 338 13159.822   22740 Chevrolet       Sedan        4     4      1     1
## 339 12495.971   26204 Chevrolet       Sedan        4     4      0     1
## 340 12678.854   28683 Chevrolet       Sedan        4     4      0     1
## 341 46732.606    3625 Chevrolet Convertible        8     2      1     1
## 342 47065.210    5239 Chevrolet Convertible        8     2      1     1
## 343 44749.687   12115 Chevrolet Convertible        8     2      1     0
## 344 42773.028   14546 Chevrolet Convertible        8     2      1     1
## 345 41371.379   20000 Chevrolet Convertible        8     2      1     0
## 346 39547.588   23826 Chevrolet Convertible        8     2      1     1
## 347 39691.727   25169 Chevrolet Convertible        8     2      1     1
## 348 38824.869   25960 Chevrolet Convertible        8     2      1     0
## 349 36970.898   30502 Chevrolet Convertible        8     2      1     1
## 350 37288.937   32039 Chevrolet Convertible        8     2      1     1
## 351 39875.854    7054 Chevrolet       Coupe        8     2      1     0
## 352 39713.668    8967 Chevrolet       Coupe        8     2      1     1
## 353 38990.607    9410 Chevrolet       Coupe        8     2      1     1
## 354 39092.190   10717 Chevrolet       Coupe        8     2      1     1
## 355 39365.883   11619 Chevrolet       Coupe        8     2      1     1
## 356 35261.436   21350 Chevrolet       Coupe        8     2      1     1
## 357 35575.417   22740 Chevrolet       Coupe        8     2      1     0
## 358 34297.305   24259 Chevrolet       Coupe        8     2      1     0
## 359 34739.215   25747 Chevrolet       Coupe        8     2      1     0
## 360 31186.741   34191 Chevrolet       Coupe        8     2      1     0
## 361 21757.050    1853 Chevrolet       Sedan        6     4      1     0
## 362 19528.100   14115 Chevrolet       Sedan        6     4      1     1
## 363 19075.679   18198 Chevrolet       Sedan        6     4      1     0
## 364 19409.753   18795 Chevrolet       Sedan        6     4      1     1
## 365 18527.209   19874 Chevrolet       Sedan        6     4      1     1
## 366 18912.982   21512 Chevrolet       Sedan        6     4      1     1
## 367 17839.801   25453 Chevrolet       Sedan        6     4      1     0
## 368 17789.347   26980 Chevrolet       Sedan        6     4      1     1
## 369 17294.181   29368 Chevrolet       Sedan        6     4      1     1
## 370 18083.396   29420 Chevrolet       Sedan        6     4      1     1
## 371 20021.195    1787 Chevrolet       Sedan        6     4      1     0
```

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## 372 18835.190    8211 Chevrolet       Sedan        6     4      1     0
## 373 18727.508   14054 Chevrolet       Sedan        6     4      1     1
## 374 16805.057   19498 Chevrolet       Sedan        6     4      1     0
## 375 17154.576   21567 Chevrolet       Sedan        6     4      1     0
## 376 16644.088   22383 Chevrolet       Sedan        6     4      1     1
## 377 15951.811   26070 Chevrolet       Sedan        6     4      1     1
## 378 16508.591   27460 Chevrolet       Sedan        6     4      1     1
## 379 15832.518   31202 Chevrolet       Sedan        6     4      1     1
## 380 15554.283   33357 Chevrolet       Sedan        6     4      1     1
## 381 25948.963     636 Chevrolet       Sedan        6     4      1     0
## 382 27714.050    5379 Chevrolet       Sedan        6     4      1     1
## 383 25097.473   14461 Chevrolet       Sedan        6     4      1     1
## 384 24809.042   16111 Chevrolet       Sedan        6     4      1     0
## 385 23345.329   22964 Chevrolet       Sedan        6     4      1     1
## 386 22894.439   26272 Chevrolet       Sedan        6     4      1     1
## 387 22064.292   27384 Chevrolet       Sedan        6     4      1     1
## 388 23151.546   27940 Chevrolet       Sedan        6     4      1     0
## 389 22120.758   28242 Chevrolet       Sedan        6     4      1     1
## 390 20294.577   33892 Chevrolet       Sedan        6     4      1     0
## 391 18957.890    5936 Chevrolet   Hatchback        6     4      0     1
## 392 18950.907    8687 Chevrolet   Hatchback        6     4      0     1
## 393 17891.634   17020 Chevrolet   Hatchback        6     4      0     1
## 394 17801.230   19386 Chevrolet   Hatchback        6     4      1     1
## 395 16723.994   19740 Chevrolet   Hatchback        6     4      1     1
## 396 16744.030   21829 Chevrolet   Hatchback        6     4      0     1
## 397 16825.191   23460 Chevrolet   Hatchback        6     4      0     1
## 398 16543.980   24583 Chevrolet   Hatchback        6     4      0     1
## 399 16143.957   26532 Chevrolet   Hatchback        6     4      1     1
## 400 14914.201   33906 Chevrolet   Hatchback        6     4      0     1
## 401 19164.611    1480 Chevrolet       Sedan        6     4      1     1
## 402 18800.959    7961 Chevrolet       Sedan        6     4      0     1
## 403 17458.222   15144 Chevrolet       Sedan        6     4      1     1
## 404 17158.922   21417 Chevrolet       Sedan        6     4      0     1
## 405 16472.898   21675 Chevrolet       Sedan        6     4      1     1
## 406 16993.780   23621 Chevrolet       Sedan        6     4      0     1
## 407 16300.465   25697 Chevrolet       Sedan        6     4      1     1
## 408 15623.200   27476 Chevrolet       Sedan        6     4      0     1
## 409 15138.401   32462 Chevrolet       Sedan        6     4      0     1
## 410 15233.160   32535 Chevrolet       Sedan        6     4      0     1
## 411 19471.975    6608 Chevrolet   Hatchback        6     4      1     1
## 412 18009.846   15190 Chevrolet   Hatchback        6     4      0     1
## 413 18273.006   16335 Chevrolet   Hatchback        6     4      0     1
## 414 18311.756   17441 Chevrolet   Hatchback        6     4      0     1
## 415 17553.754   18451 Chevrolet   Hatchback        6     4      0     1
## 416 18004.870   18771 Chevrolet   Hatchback        6     4      0     1
## 417 17663.225   19490 Chevrolet   Hatchback        6     4      1     1
## 418 17115.122   24461 Chevrolet   Hatchback        6     4      0     1
## 419 16988.303   24905 Chevrolet   Hatchback        6     4      1     1
## 420 16803.123   25874 Chevrolet   Hatchback        6     4      1     1
## 421 19446.883     932 Chevrolet       Sedan        6     4      0     1
## 422 17119.458   18277 Chevrolet       Sedan        6     4      1     1
## 423 17316.097   19593 Chevrolet       Sedan        6     4      1     1
## 424 16860.871   19883 Chevrolet       Sedan        6     4      1     1
## 425 17312.907   21420 Chevrolet       Sedan        6     4      1     1
```

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## 426 16403.254   23133 Chevrolet       Sedan        6     4      1     1
## 427 16536.744   24218 Chevrolet       Sedan        6     4      1     1
## 428 16341.804   25394 Chevrolet       Sedan        6     4      0     1
## 429 16713.985   26328 Chevrolet       Sedan        6     4      1     1
## 430 16295.211   28239 Chevrolet       Sedan        6     4      0     1
## 431 18974.922    5632 Chevrolet   Hatchback        6     4      0     1
## 432 18324.832    7397 Chevrolet   Hatchback        6     4      1     1
## 433 19581.231    7645 Chevrolet   Hatchback        6     4      0     1
## 434 18169.375   14754 Chevrolet   Hatchback        6     4      0     1
## 435 17986.224   17488 Chevrolet   Hatchback        6     4      0     1
## 436 17173.942   18721 Chevrolet   Hatchback        6     4      0     1
## 437 16456.975   20200 Chevrolet   Hatchback        6     4      0     1
## 438 16267.095   21452 Chevrolet   Hatchback        6     4      0     1
## 439 16860.094   22841 Chevrolet   Hatchback        6     4      1     1
## 440 16027.286   22889 Chevrolet   Hatchback        6     4      0     1
## 441 17089.919    8732 Chevrolet       Sedan        6     4      0     1
## 442 17463.046   11393 Chevrolet       Sedan        6     4      1     1
## 443 17218.686   14579 Chevrolet       Sedan        6     4      1     1
## 444 17162.478   15903 Chevrolet       Sedan        6     4      0     1
## 445 16507.070   17451 Chevrolet       Sedan        6     4      0     1
## 446 16752.514   18562 Chevrolet       Sedan        6     4      1     1
## 447 16646.771   20154 Chevrolet       Sedan        6     4      0     1
## 448 15623.920   21272 Chevrolet       Sedan        6     4      1     1
## 449 15664.625   25787 Chevrolet       Sedan        6     4      1     1
## 450 15680.864   25956 Chevrolet       Sedan        6     4      0     1
## 451 18800.093    5827 Chevrolet       Coupe        6     2      1     0
## 452 18910.804    8345 Chevrolet       Coupe        6     2      1     0
## 453 19177.412   10414 Chevrolet       Coupe        6     2      1     1
## 454 18040.144   11647 Chevrolet       Coupe        6     2      1     0
## 455 17685.201   15898 Chevrolet       Coupe        6     2      1     0
## 456 17515.398   18602 Chevrolet       Coupe        6     2      1     0
## 457 16357.992   23491 Chevrolet       Coupe        6     2      1     1
## 458 16345.944   25931 Chevrolet       Coupe        6     2      1     1
## 459 15797.196   26700 Chevrolet       Coupe        6     2      1     1
## 460 15503.509   33345 Chevrolet       Coupe        6     2      1     0
## 461 21745.029    7065 Chevrolet       Coupe        6     2      1     1
## 462 21725.011   13457 Chevrolet       Coupe        6     2      1     1
## 463 22384.119   14788 Chevrolet       Coupe        6     2      1     1
## 464 20537.142   16950 Chevrolet       Coupe        6     2      1     0
## 465 21233.911   17337 Chevrolet       Coupe        6     2      1     1
## 466 20676.166   18021 Chevrolet       Coupe        6     2      1     0
## 467 20839.150   22152 Chevrolet       Coupe        6     2      1     1
## 468 20017.968   22729 Chevrolet       Coupe        6     2      1     0
## 469 18876.871   27218 Chevrolet       Coupe        6     2      1     1
## 470 17586.929   39049 Chevrolet       Coupe        6     2      1     0
## 471 23573.822   12466 Chevrolet       Coupe        6     2      1     1
## 472 23527.729   14948 Chevrolet       Coupe        6     2      1     1
## 473 22113.628   21992 Chevrolet       Coupe        6     2      1     1
## 474 22470.358   22626 Chevrolet       Coupe        6     2      1     1
## 475 20619.114   24067 Chevrolet       Coupe        6     2      1     0
## 476 20047.951   24665 Chevrolet       Coupe        6     2      1     1
## 477 21525.339   25020 Chevrolet       Coupe        6     2      1     1
## 478 20382.150   25240 Chevrolet       Coupe        6     2      1     1
## 479 21020.837   25550 Chevrolet       Coupe        6     2      1     1
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## 480 20221.809   26223 Chevrolet       Coupe        6     2      1     1
## 481 25452.474   11892   Pontiac       Sedan        8     4      1     0
## 482 23449.306   17273   Pontiac       Sedan        8     4      1     0
## 483 23578.165   19148   Pontiac       Sedan        8     4      1     0
## 484 22525.270   19521   Pontiac       Sedan        8     4      1     1
## 485 21982.648   20472   Pontiac       Sedan        8     4      1     1
## 486 22231.563   21929   Pontiac       Sedan        8     4      1     1
## 487 22189.116   25651   Pontiac       Sedan        8     4      1     0
## 488 21765.067   25794   Pontiac       Sedan        8     4      1     0
## 489 21403.756   27168   Pontiac       Sedan        8     4      1     0
## 490 21200.690   31197   Pontiac       Sedan        8     4      1     1
## 491 19682.035   11554   Pontiac       Sedan        6     4      1     0
## 492 18678.414   16496   Pontiac       Sedan        6     4      1     1
## 493 20318.891   17583   Pontiac       Sedan        6     4      1     1
## 494 20127.044   18419   Pontiac       Sedan        6     4      1     1
## 495 19751.041   20510   Pontiac       Sedan        6     4      1     0
## 496 17844.731   21121   Pontiac       Sedan        6     4      1     1
## 497 18856.019   22423   Pontiac       Sedan        6     4      1     1
## 498 18566.071   24747   Pontiac       Sedan        6     4      1     1
## 499 18063.005   27574   Pontiac       Sedan        6     4      1     0
## 500 17768.060   28385   Pontiac       Sedan        6     4      1     1
## 501 23197.437    2295   Pontiac       Sedan        6     4      1     1
## 502 23102.022    5653   Pontiac       Sedan        6     4      1     0
## 503 22460.530    8928   Pontiac       Sedan        6     4      1     0
## 504 21607.773   11069   Pontiac       Sedan        6     4      1     0
## 505 22004.930   15516   Pontiac       Sedan        6     4      1     1
## 506 20830.994   19419   Pontiac       Sedan        6     4      1     1
## 507 20109.904   22891   Pontiac       Sedan        6     4      1     1
## 508 19116.131   26252   Pontiac       Sedan        6     4      1     0
## 509 19689.741   27077   Pontiac       Sedan        6     4      1     1
## 510 19338.376   27966   Pontiac       Sedan        6     4      1     0
## 511 21903.323    4537   Pontiac       Sedan        6     4      1     1
## 512 22736.834    5690   Pontiac       Sedan        6     4      1     1
## 513 22104.974    9049   Pontiac       Sedan        6     4      1     1
## 514 22311.050   11221   Pontiac       Sedan        6     4      1     1
## 515 21875.098   12313   Pontiac       Sedan        6     4      1     0
## 516 20627.662   20770   Pontiac       Sedan        6     4      1     1
## 517 19540.245   22628   Pontiac       Sedan        6     4      1     1
## 518 19204.809   26477   Pontiac       Sedan        6     4      1     0
## 519 18158.083   28354   Pontiac       Sedan        6     4      1     0
## 520 18529.342   30063   Pontiac       Sedan        6     4      1     0
## 521 21383.067    7287   Pontiac       Sedan        6     4      1     1
## 522 20452.669   10338   Pontiac       Sedan        6     4      1     0
## 523 20677.594   11204   Pontiac       Sedan        6     4      1     1
## 524 19294.787   19539   Pontiac       Sedan        6     4      1     0
## 525 18548.979   20870   Pontiac       Sedan        6     4      1     0
## 526 18042.221   21702   Pontiac       Sedan        6     4      1     0
## 527 18620.871   25516   Pontiac       Sedan        6     4      1     0
## 528 17023.937   30404   Pontiac       Sedan        6     4      1     0
## 529 16216.981   35624   Pontiac       Sedan        6     4      1     1
## 530 15792.831   41566   Pontiac       Sedan        6     4      1     1
## 531 17360.811     881   Pontiac       Coupe        6     2      0     1
## 532 17675.837    5131   Pontiac       Coupe        6     2      0     1
## 533 17141.941    6761   Pontiac       Coupe        6     2      1     1
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## 534 17202.834    9380   Pontiac       Coupe        6     2      0     1
## 535 16792.680   12071   Pontiac       Coupe        6     2      1     1
## 536 15595.884   18315   Pontiac       Coupe        6     2      0     1
## 537 15253.869   20917   Pontiac       Coupe        6     2      1     1
## 538 15594.807   22414   Pontiac       Coupe        6     2      0     1
## 539 15059.134   22641   Pontiac       Coupe        6     2      1     1
## 540 14703.137   23335   Pontiac       Coupe        6     2      0     1
## 541 15979.015    3946   Pontiac       Sedan        4     4      1     1
## 542 16379.853    4188   Pontiac       Sedan        4     4      1     1
## 543 15327.100    4318   Pontiac       Sedan        4     4      0     1
## 544 15846.013    5350   Pontiac       Sedan        4     4      0     1
## 545 15604.146    5788   Pontiac       Sedan        4     4      1     1
## 546 14841.917   12420   Pontiac       Sedan        4     4      0     1
## 547 15077.176   13262   Pontiac       Sedan        4     4      0     1
## 548 13961.112   19602   Pontiac       Sedan        4     4      0     1
## 549 13034.069   23976   Pontiac       Sedan        4     4      0     1
## 550 13162.852   24542   Pontiac       Sedan        4     4      0     1
## 551 18254.923   16554   Pontiac       Sedan        6     4      1     1
## 552 17095.035   18720   Pontiac       Sedan        6     4      1     0
## 553 17162.873   20829   Pontiac       Sedan        6     4      1     0
## 554 16391.172   21304   Pontiac       Sedan        6     4      1     1
## 555 15788.105   25295   Pontiac       Sedan        6     4      1     1
## 556 16569.141   25777   Pontiac       Sedan        6     4      1     0
## 557 16997.694   25830   Pontiac       Sedan        6     4      1     0
## 558 16283.959   26511   Pontiac       Sedan        6     4      1     0
## 559 15457.171   29925   Pontiac       Sedan        6     4      1     1
## 560 14963.046   31471   Pontiac       Sedan        6     4      1     1
## 561 21230.978   11229   Pontiac       Sedan        6     4      1     1
## 562 22100.393   12314   Pontiac       Sedan        6     4      1     1
## 563 21300.019   12772   Pontiac       Sedan        6     4      1     1
## 564 21281.880   17417   Pontiac       Sedan        6     4      1     1
## 565 19646.717   21132   Pontiac       Sedan        6     4      1     1
## 566 20173.906   21211   Pontiac       Sedan        6     4      1     0
## 567 18701.223   24992   Pontiac       Sedan        6     4      1     0
## 568 19423.165   25557   Pontiac       Sedan        6     4      1     0
## 569 19956.758   26028   Pontiac       Sedan        6     4      1     1
## 570 19448.226   27721   Pontiac       Sedan        6     4      1     0
## 571 19822.115    1592   Pontiac       Sedan        6     4      1     1
## 572 19567.259    2189   Pontiac       Sedan        6     4      1     1
## 573 16853.108   17959   Pontiac       Sedan        6     4      1     0
## 574 16516.956   20751   Pontiac       Sedan        6     4      1     1
## 575 15979.015   21974   Pontiac       Sedan        6     4      1     0
## 576 16256.236   22637   Pontiac       Sedan        6     4      1     0
## 577 15724.252   23989   Pontiac       Sedan        6     4      1     0
## 578 15967.245   25598   Pontiac       Sedan        6     4      1     0
## 579 16041.686   27800   Pontiac       Sedan        6     4      1     1
## 580 15756.146   29325   Pontiac       Sedan        6     4      1     1
## 581 32422.761    9185   Pontiac       Coupe        8     2      1     1
## 582 32219.589   10915   Pontiac       Coupe        8     2      1     1
## 583 31024.872   13678   Pontiac       Coupe        8     2      1     1
## 584 29595.794   16193   Pontiac       Coupe        8     2      1     0
## 585 29664.703   21418   Pontiac       Coupe        8     2      1     0
## 586 27425.844   23886   Pontiac       Coupe        8     2      1     0
## 587 27370.958   24960   Pontiac       Coupe        8     2      1     1
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## 588 27548.630   26126   Pontiac       Coupe        8     2      1     1
## 589 28502.306   27199   Pontiac       Coupe        8     2      1     1
## 590 25527.013   36480   Pontiac       Coupe        8     2      1     1
## 591 13160.125   13145   Pontiac       Coupe        4     2      0     1
## 592 12830.099   17830   Pontiac       Coupe        4     2      1     1
## 593 12828.031   19081   Pontiac       Coupe        4     2      1     1
## 594 12878.047   19225   Pontiac       Coupe        4     2      1     1
## 595 12832.462   20618   Pontiac       Coupe        4     2      1     1
## 596 12464.073   21891   Pontiac       Coupe        4     2      1     1
## 597 12465.509   23931   Pontiac       Coupe        4     2      0     1
## 598 12258.858   24318   Pontiac       Coupe        4     2      1     1
## 599 11903.098   25285   Pontiac       Coupe        4     2      0     1
## 600 12209.560   26097   Pontiac       Coupe        4     2      0     1
## 601 16391.927   18096   Pontiac       Wagon        4     4      1     1
## 602 16033.931   18391   Pontiac       Wagon        4     4      0     1
## 603 16106.827   19465   Pontiac       Wagon        4     4      1     0
## 604 16551.220   19531   Pontiac       Wagon        4     4      1     1
## 605 17325.270   19894   Pontiac       Wagon        4     4      1     0
## 606 16078.665   22779   Pontiac       Wagon        4     4      0     0
## 607 15297.836   23062   Pontiac       Wagon        4     4      0     0
## 608 15505.294   24239   Pontiac       Wagon        4     4      1     0
## 609 15174.347   27887   Pontiac       Wagon        4     4      0     0
## 610 14546.885   33374   Pontiac       Wagon        4     4      0     1
## 611 17803.279   12303   Pontiac       Wagon        4     4      1     1
## 612 16353.097   16078   Pontiac       Wagon        4     4      0     1
## 613 15977.911   17053   Pontiac       Wagon        4     4      0     0
## 614 15568.974   18206   Pontiac       Wagon        4     4      0     0
## 615 15589.780   21307   Pontiac       Wagon        4     4      0     0
## 616 15730.046   21391   Pontiac       Wagon        4     4      0     1
## 617 15802.653   21461   Pontiac       Wagon        4     4      0     0
## 618 15086.900   27438   Pontiac       Wagon        4     4      0     0
## 619 14396.271   31424   Pontiac       Wagon        4     4      0     0
## 620 14869.282   31791   Pontiac       Wagon        4     4      1     1
## 621 16927.780    2973   Pontiac       Wagon        4     4      0     0
## 622 17418.069    4463   Pontiac       Wagon        4     4      1     0
## 623 16379.099    8754   Pontiac       Wagon        4     4      0     1
## 624 16706.674    9150   Pontiac       Wagon        4     4      0     0
## 625 17214.325   12610   Pontiac       Wagon        4     4      1     1
## 626 15821.950   14304   Pontiac       Wagon        4     4      0     0
## 627 14398.923   21688   Pontiac       Wagon        4     4      0     0
## 628 15622.121   23217   Pontiac       Wagon        4     4      1     1
## 629 14909.051   23323   Pontiac       Wagon        4     4      0     1
## 630 14853.199   24270   Pontiac       Wagon        4     4      0     0
## 631 35622.139   10340      SAAB Convertible        4     2      1     1
## 632 34819.297   12251      SAAB Convertible        4     2      1     0
## 633 34355.004   17711      SAAB Convertible        4     2      1     1
## 634 32737.085   19112      SAAB Convertible        4     2      1     1
## 635 33540.536   20925      SAAB Convertible        4     2      1     0
## 636 31970.542   21208      SAAB Convertible        4     2      1     1
## 637 33287.410   21661      SAAB Convertible        4     2      1     0
## 638 32075.985   23553      SAAB Convertible        4     2      1     1
## 639 31969.070   24559      SAAB Convertible        4     2      1     0
## 640 27666.231   35157      SAAB Convertible        4     2      1     0
## 641 29246.237    3907      SAAB        Sedan        4     4      1     0
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## 642 26337.831   16068      SAAB       Sedan        4     4      1     0
## 643 26775.032   16688      SAAB       Sedan        4     4      1     0
## 644 25299.970   19569      SAAB       Sedan        4     4      1     1
## 645 24896.598   21266      SAAB       Sedan        4     4      1     1
## 646 25996.806   21433      SAAB       Sedan        4     4      1     1
## 647 24801.617   26345      SAAB       Sedan        4     4      1     1
## 648 24063.013   27674      SAAB       Sedan        4     4      1     1
## 649 23249.842   27686      SAAB       Sedan        4     4      1     0
## 650 22244.877   50387      SAAB       Sedan        4     4      1     0
## 651 37088.562    3828      SAAB Convertible        4     2      1     1
## 652 33381.819   17381      SAAB Convertible        4     2      1     1
## 653 33358.768   17590      SAAB Convertible        4     2      1     1
## 654 33586.906   18930      SAAB Convertible        4     2      1     0
## 655 30731.942   22479      SAAB Convertible        4     2      1     0
## 656 30315.169   23635      SAAB Convertible        4     2      1     0
## 657 30166.853   25049      SAAB Convertible        4     2      1     0
## 658 30251.018   27558      SAAB Convertible        4     2      1     0
## 659 29142.714   31655      SAAB Convertible        4     2      1     1
## 660 29612.154   32477      SAAB Convertible        4     2      1     1
## 661 26841.081   10003      SAAB       Sedan        4     4      1     1
## 662 27825.950   10014      SAAB       Sedan        4     4      1     0
## 663 27284.751   14281      SAAB       Sedan        4     4      1     1
## 664 27060.138   17319      SAAB       Sedan        4     4      1     0
## 665 25618.282   20208      SAAB       Sedan        4     4      1     0
## 666 25790.514   21160      SAAB       Sedan        4     4      1     1
## 667 25148.379   22272      SAAB       Sedan        4     4      1     1
## 668 24852.495   22814      SAAB       Sedan        4     4      1     1
## 669 24173.526   27015      SAAB       Sedan        4     4      1     0
## 670 23733.402   27600      SAAB       Sedan        4     4      1     1
## 671 38324.809   12090      SAAB Convertible        4     2      1     1
## 672 38167.174   13162      SAAB Convertible        4     2      1     0
## 673 37383.503   16088      SAAB Convertible        4     2      1     0
## 674 36338.751   18195      SAAB Convertible        4     2      1     1
## 675 35580.332   21167      SAAB Convertible        4     2      1     1
## 676 35304.495   21293      SAAB Convertible        4     2      1     0
## 677 34392.995   24031      SAAB Convertible        4     2      1     0
## 678 33984.431   25420      SAAB Convertible        4     2      1     0
## 679 33248.343   27051      SAAB Convertible        4     2      1     0
## 680 28777.960   48991      SAAB Convertible        4     2      1     1
## 681 32197.340    3867      SAAB       Sedan        4     4      1     1
## 682 32053.097    5144      SAAB       Sedan        4     4      1     1
## 683 30274.711   10800      SAAB       Sedan        4     4      1     1
## 684 30353.586   11273      SAAB       Sedan        4     4      1     1
## 685 30122.430   14568      SAAB       Sedan        4     4      1     1
## 686 26789.833   22189      SAAB       Sedan        4     4      1     0
## 687 28291.762   22328      SAAB       Sedan        4     4      1     1
## 688 27109.406   22598      SAAB       Sedan        4     4      1     0
## 689 27256.495   26400      SAAB       Sedan        4     4      1     1
## 690 25267.368   34175      SAAB       Sedan        4     4      1     1
## 691 35033.215    1676      SAAB       Sedan        4     4      1     1
## 692 32746.131    7924      SAAB       Sedan        4     4      1     0
## 693 33183.333    9795      SAAB       Sedan        4     4      1     1
## 694 31002.734   15087      SAAB       Sedan        4     4      1     1
## 695 30075.995   22052      SAAB       Sedan        4     4      1     1
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## 696 29844.204   23143      SAAB       Sedan        4     4      1     1
## 697 28432.824   25247      SAAB       Sedan        4     4      1     1
## 698 28054.982   26276      SAAB       Sedan        4     4      1     1
## 699 28502.962   28598      SAAB       Sedan        4     4      1     1
## 700 24912.081   38717      SAAB       Sedan        4     4      1     0
## 701 31849.308   16956      SAAB       Wagon        4     4      1     0
## 702 32649.761   16975      SAAB       Wagon        4     4      1     1
## 703 29961.255   20015      SAAB       Wagon        4     4      1     1
## 704 31554.405   20103      SAAB       Wagon        4     4      1     1
## 705 29914.380   22105      SAAB       Wagon        4     4      1     0
## 706 30575.249   22298      SAAB       Wagon        4     4      1     1
## 707 30271.922   23426      SAAB       Wagon        4     4      1     1
## 708 28678.075   25380      SAAB       Wagon        4     4      1     0
## 709 28829.028   26503      SAAB       Wagon        4     4      1     0
## 710 26955.041   31773      SAAB       Wagon        4     4      1     0
## 711 33005.780    6409      SAAB       Wagon        4     4      1     1
## 712 30661.260   14278      SAAB       Wagon        4     4      1     0
## 713 30443.880   15050      SAAB       Wagon        4     4      1     0
## 714 30322.151   16225      SAAB       Wagon        4     4      1     1
## 715 31153.009   17317      SAAB       Wagon        4     4      1     0
## 716 31084.938   18187      SAAB       Wagon        4     4      1     1
## 717 31156.596   18805      SAAB       Wagon        4     4      1     1
## 718 29114.545   21960      SAAB       Wagon        4     4      1     0
## 719 25845.206   36557      SAAB       Wagon        4     4      1     1
## 720 24903.478   40719      SAAB       Wagon        4     4      1     1
## 721 30800.658    8017      SAAB       Sedan        4     4      1     0
## 722 28416.462   14613      SAAB       Sedan        4     4      1     0
## 723 28185.776   19854      SAAB       Sedan        4     4      1     1
## 724 28204.604   22021      SAAB       Sedan        4     4      1     1
## 725 26653.239   22590      SAAB       Sedan        4     4      1     1
## 726 27610.864   22881      SAAB       Sedan        4     4      1     1
## 727 26698.078   23055      SAAB       Sedan        4     4      1     1
## 728 27241.436   23204      SAAB       Sedan        4     4      1     1
## 729 27703.204   24738      SAAB       Sedan        4     4      1     1
## 730 24405.067   31344      SAAB       Sedan        4     4      1     1
## 731 30959.932   17673      SAAB       Wagon        4     4      1     1
## 732 29986.791   18464      SAAB       Wagon        4     4      1     0
## 733 29908.181   19830      SAAB       Wagon        4     4      1     1
## 734 28328.267   20685      SAAB       Wagon        4     4      1     0
## 735 29197.791   20907      SAAB       Wagon        4     4      1     0
## 736 29321.083   21545      SAAB       Wagon        4     4      1     0
## 737 29481.529   21822      SAAB       Wagon        4     4      1     1
## 738 26792.300   25357      SAAB       Wagon        4     4      1     0
## 739 27788.813   26786      SAAB       Wagon        4     4      1     0
## 740 26012.375   34269      SAAB       Wagon        4     4      1     1
## 741 27280.982    4836      SAAB       Wagon        4     4      1     1
## 742 25959.122   17431      SAAB       Wagon        4     4      1     0
## 743 23274.481   21616      SAAB       Wagon        4     4      1     1
## 744 23329.208   25218      SAAB       Wagon        4     4      1     0
## 745 16916.870    2879    Saturn       Coupe        4     2      1     0
## 746 15639.037    8507    Saturn       Coupe        4     2      1     0
## 747 16256.236   10555    Saturn       Coupe        4     2      0     0
## 748 15395.011   12920    Saturn       Coupe        4     2      1     0
## 749 14881.955   14376    Saturn       Coupe        4     2      0     0
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## 750 15277.068   16951    Saturn       Coupe        4     2      0     1
## 751 14702.798   17656    Saturn       Coupe        4     2      1     1
## 752 15033.150   19455    Saturn       Coupe        4     2      0     0
## 753 13991.040   21020    Saturn       Coupe        4     2      0     1
## 754 14771.003   22255    Saturn       Coupe        4     2      1     0
## 755 13719.238   23645    Saturn       Coupe        4     2      0     0
## 756 13869.155   24349    Saturn       Coupe        4     2      1     1
## 757 13518.235   25981    Saturn       Coupe        4     2      1     1
## 758 13825.155   26034    Saturn       Coupe        4     2      0     0
## 759 13811.155   26236    Saturn       Coupe        4     2      0     1
## 760 14077.969   26788    Saturn       Coupe        4     2      0     0
## 761 14411.859   26986    Saturn       Coupe        4     2      1     0
## 762 13600.034   27231    Saturn       Coupe        4     2      0     1
## 763 13032.868   30108    Saturn       Coupe        4     2      1     1
## 764 11539.049   38958    Saturn       Coupe        4     2      0     0
## 765 14739.067    1737    Saturn       Sedan        4     4      0     0
## 766 15110.193    2392    Saturn       Sedan        4     4      1     1
## 767 14202.997   11836    Saturn       Sedan        4     4      0     0
## 768 15194.975   12412    Saturn       Sedan        4     4      0     0
## 769 14116.922   12878    Saturn       Sedan        4     4      1     0
## 770 13174.071   13318    Saturn       Sedan        4     4      0     0
## 771 13258.366   14938    Saturn       Sedan        4     4      1     1
## 772 12791.751   16163    Saturn       Sedan        4     4      0     0
## 773 12293.060   17139    Saturn       Sedan        4     4      1     0
## 774 13998.129   18257    Saturn       Sedan        4     4      0     1
## 775 14568.002   18511    Saturn       Sedan        4     4      0     1
## 776 13122.905   19101    Saturn       Sedan        4     4      0     1
## 777 13494.289   19500    Saturn       Sedan        4     4      1     0
## 778 12036.217   19853    Saturn       Sedan        4     4      0     1
## 779 12162.140   21770    Saturn       Sedan        4     4      0     1
## 780 12333.604   21877    Saturn       Sedan        4     4      0     0
## 781 12099.015   22758    Saturn       Sedan        4     4      1     1
## 782 12119.090   22826    Saturn       Sedan        4     4      0     0
## 783 11679.924   23388    Saturn       Sedan        4     4      0     0
## 784 13216.912   24069    Saturn       Sedan        4     4      0     1
## 785 12412.521   24664    Saturn       Sedan        4     4      0     1
## 786 12284.288   24740    Saturn       Sedan        4     4      1     1
## 787 12594.183   26328    Saturn       Sedan        4     4      0     0
## 788 12105.981   28298    Saturn       Sedan        4     4      0     1
## 789 11873.534   28398    Saturn       Sedan        4     4      0     0
## 790 12965.223   29707    Saturn       Sedan        4     4      0     1
## 791 10563.066   32458    Saturn       Sedan        4     4      0     0
## 792 11413.530   32619    Saturn       Sedan        4     4      1     0
## 793 11504.825   33962    Saturn       Sedan        4     4      0     0
## 794 11521.526   34998    Saturn       Sedan        4     4      0     1
## 795 18173.978    5826    Saturn       Sedan        6     4      1     1
## 796 18490.983    7755    Saturn       Sedan        6     4      1     1
## 797 17322.078   10102    Saturn       Sedan        6     4      1     0
## 798 17978.357   10986    Saturn       Sedan        6     4      1     0
## 799 16425.175   14242    Saturn       Sedan        6     4      1     0
## 800 16507.070   16229    Saturn       Sedan        6     4      1     0
## 801 16175.958   19095    Saturn       Sedan        6     4      1     1
## 802 15731.133   20484    Saturn       Sedan        6     4      1     1
## 803 15118.893   25979    Saturn       Sedan        6     4      1     1
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## 804 13585.637   35662    Saturn       Sedan        6     4      1     0
##     Leather
## 1         1
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## 797       1
## 798       0
## 799       0
## 800       0
## 801       0
## 802       0
## 803       0
## 804       0
```

```
str(df)
```

```
## 'data.frame':    804 obs. of  9 variables:
##  $ Price   : num  17314 17542 16219 16337 16339 ...
```

```
##  $ Mileage : int  8221 9135 13196 16342 19832 22236 22576 22964 24021 27325 ...
##  $ Make    : chr  "Buick" "Buick" "Buick" "Buick" ...
##  $ Type    : chr  "Sedan" "Sedan" "Sedan" "Sedan" ...
##  $ Cylinder: int  6 6 6 6 6 6 6 6 6 6 ...
##  $ Doors   : int  4 4 4 4 4 4 4 4 4 4 ...
##  $ Cruise  : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Sound   : int  1 1 1 0 0 1 1 1 0 1 ...
##  $ Leather : int  1 0 0 0 1 0 0 0 1 1 ...
```

```
df2 <- df

# df<-data.frame(as.numeric(unlist(CarPrice_Estimate)))
```

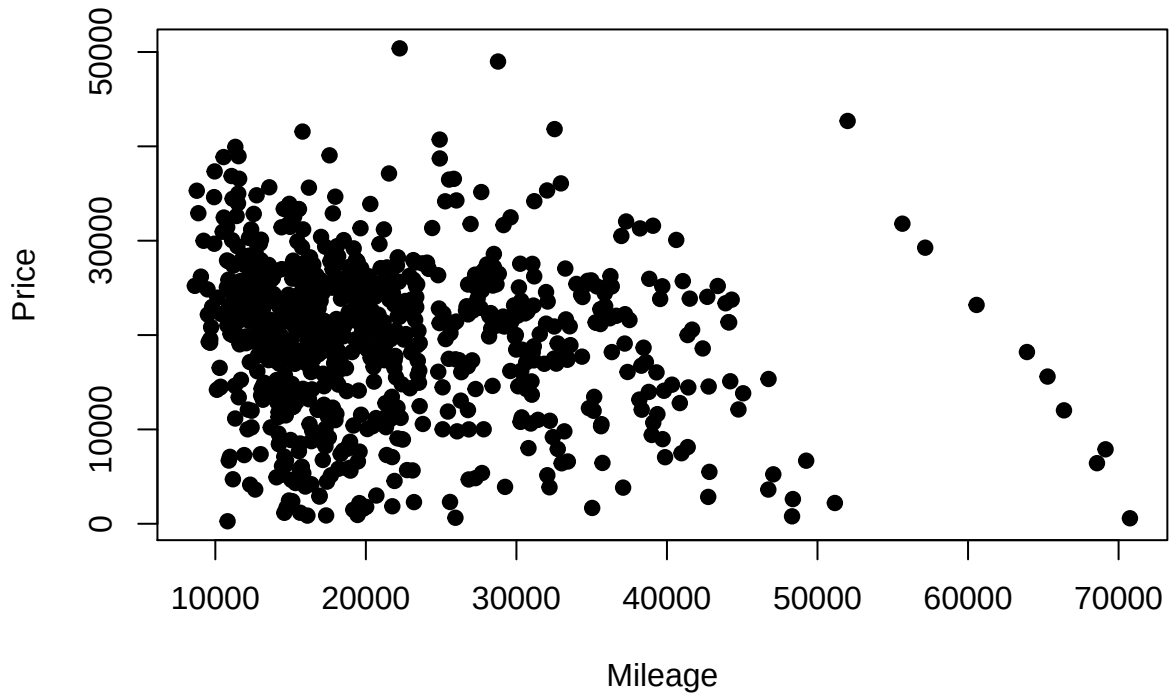
Since the number of independent variables is less (11), I am considering total 11 variables for my regression model.

So, my independent variables are:

```
colnames(CarPrice_Estimate[2:9])
```

```
## [1] "Mileage"  "Make"     "Type"     "Cylinder" "Doors"    "Cruise"
## [7] "Sound"    "Leather"
```

```
plot(df$Price, df$Mileage, xlab = "Mileage", ylab = "Price", pch=19)
```




```
df3 <- par(no.readonly = T)
par(mfrow = c(4,4))

library(ggplot2)
```

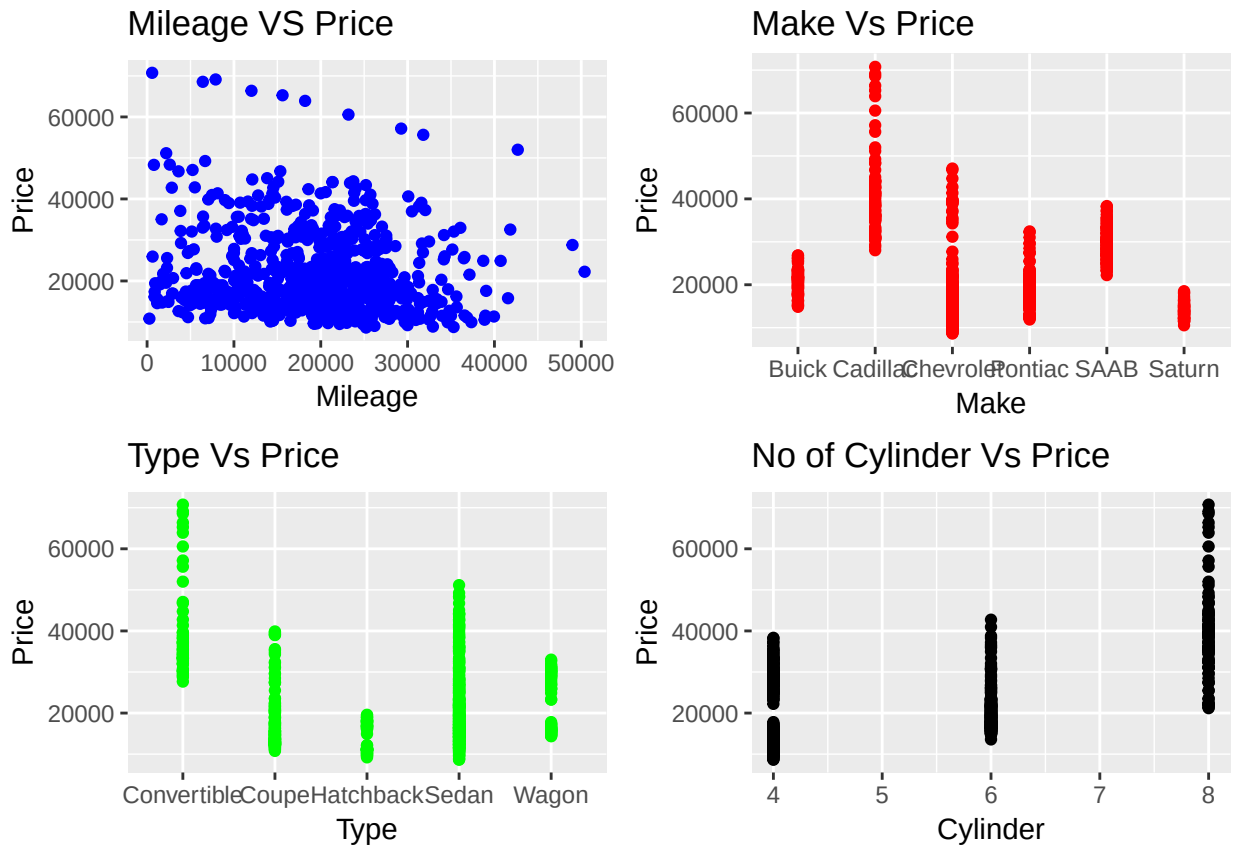
```
library(gridExtra)
p1 <- ggplot(data = df)+
    geom_point(mapping = aes(x=df$Mileage, y=df$Price), color='blue')+
    xlab("Mileage") + ylab("Price") +
    ggtitle("Mileage VS Price")

p2 <- ggplot(data = df)+
  geom_point(mapping = aes(x=df$Make, y=df$Price), color='red')+
  xlab("Make") + ylab("Price") +
  ggtitle("Make Vs Price")

p3 <- ggplot(data = df)+
  geom_point(mapping = aes(x=df$Type, y=df$Price), color='green')+
  xlab("Type") + ylab("Price") +
  ggtitle("Type Vs Price")

p4 <- ggplot(data = df)+
  geom_point(mapping = aes(x=df$Cylinder, y=df$Price), color='black')+
  xlab("Cylinder") + ylab("Price") +
  ggtitle("No of Cylinder Vs Price")

grid.arrange(p1, p2, p3, p4, ncol=2)
```




Prior to running the regression, plotting price vs mileage, it is difficult to find a particular relationship as the plot is scattered.

I have also plotted a scatter plot of the numerical variables (excluding categorical variables of Cruise, Sound and Leather since they are in 1's and 0's) from which Convertibles, Cadillac(Make) and 8-cylindered vehicles seem to fetch high prices.

5. Explain and show in detail how you rename and recode the variables you are examining, and what units each are measured in.

For recoding the categorical variables, I follow the process of dummy encoding by converting it into numeric binaries of 1,0. Price is measured in US dollars, Mileage is measured in miles but other independent variables are integer whole numbers.

```
# Dummy coding to convert categorical variables to numeric
# For variable 'Make'
df$Make_Cadi  <- ifelse(df$Make == "Cadillac",1,0)
df$Make_Chev  <- ifelse(df$Make == "Chevrolet",1,0)
df$Make_Ponti <- ifelse(df$Make == "Pontiac",1,0)
df$Make_SAAB  <- ifelse(df$Make == "SAAB",1,0)
df$Make_Sat   <- ifelse(df$Make == "Saturn",1,0)

# For variable 'Type'
df$Type_Coup <- ifelse(df$Type == "Coupe",1,0)
df$Type_Hatch <-ifelse(df$Type == "Hatchback",1,0)
df$Type_Sedan <-ifelse(df$Type == "Sedan",1,0)
df$Type_Wagon <-ifelse(df$Type == "Wagon",1,0)

# For variable 'Cylinder'
df$Cylinder_6 <- ifelse(df$Cylinder == "6",1,0)
df$Cylinder_8 <- ifelse(df$Cylinder == "8",1,0)

# For variable 'doors'
df$door_4 <- ifelse(df$Doors == "4",1,0)

# For variable 'cruise'
df$Cruise_Y <- ifelse(df$Cruise == "1",1,0)

# For variable 'Sound'
df$Sound_Y <- ifelse(df$Sound == "1",1,0)

# For variable Leather
df$Leather_Y <- ifelse(df$Leather == "1",1,0)
```

```
# Dropping Make and Type since already dummies have been created
df<-df[,c(-3:-7)]
cor(df)
```

```
##                  Price      Mileage       Sound      Leather   Make_Cadi
## Price       1.00000000 -0.143050506 -0.12434785  0.157196855  0.65929676
## Mileage    -0.14305051  1.000000000 -0.02614593  0.001005446 -0.03747172
## Sound      -0.12434785 -0.026145926  1.00000000  0.165443625 -0.09193204
## Leather     0.15719686  0.001005446  0.16544362  1.000000000  0.20530083
## Make_Cadi   0.65929676 -0.037471715 -0.09193204  0.205300830  1.00000000
## Make_Chev  -0.40459823 -0.017505346  0.25956627  0.155492004 -0.27028878
## Make_Ponti -0.14209508 -0.029892476 -0.07431422 -0.089853777 -0.15919612
## Make_SAAB   0.33540436  0.056182113 -0.08720864  0.003809046 -0.13511501
## Make_Sat   -0.21170095  0.017466762 -0.13937106 -0.152794474 -0.09439845
## Type_Coup  -0.16808691  0.001509632  0.09783825  0.063507235 -0.15263555
```

```
## Type_Hatch -0.20617811 -0.025691441  0.07354434  0.090697030 -0.09439845
## Type_Sedan -0.03480225 -0.015904640 -0.01507940 -0.100940416  0.18093006
## Type_Wagon  0.04513386  0.027015682 -0.14236165 -0.003374894 -0.09775744
## Cylinder_6 -0.10117891 -0.025956046  0.04640653 -0.208070612 -0.09258868
## Cylinder_8  0.67241960 -0.011806702 -0.12845350  0.232770889  0.63016948
## door_4     -0.13874965 -0.016944490 -0.06253031 -0.061968579  0.08710393
## Cruise_Y    0.43085149  0.025036652 -0.09173015 -0.070573094  0.19064462
## Sound_Y    -0.12434785 -0.026145926  1.00000000  0.165443625 -0.09193204
## Leather_Y   0.15719686  0.001005446  0.16544362  1.000000000  0.20530083
##              Make_Chev    Make_Ponti    Make_SAAB    Make_Sat    Type_Coup
## Price      -0.40459823 -0.1420950803  0.335404360 -0.21170095 -0.168086912
## Mileage    -0.01750535 -0.0298924762  0.056182113  0.01746676  0.001509632
## Sound       0.25956627 -0.0743142240 -0.087208644 -0.13937106  0.097838246
## Leather     0.15549200 -0.0898537770  0.003809046 -0.15279447  0.063507235
## Make_Cadi  -0.27028878 -0.1591961153 -0.135115008 -0.09439845 -0.152635547
## Make_Chev   1.00000000 -0.3894117608 -0.330506640 -0.23090932  0.229685451
## Make_Ponti -0.38941176  1.0000000000 -0.194663548 -0.13600219  0.032671723
## Make_SAAB  -0.33050664 -0.1946635484  1.000000000 -0.11542956 -0.186641346
## Make_Sat   -0.23090932 -0.1360021935 -0.115429559  1.00000000  0.119220536
## Type_Coup   0.22968545  0.0326717226 -0.186641346  0.11922054  1.000000000
## Type_Hatch  0.34925035 -0.1360021935 -0.115429559 -0.08064516 -0.130397461
## Type_Sedan -0.18241986 -0.0092791348 -0.142348181  0.03330306 -0.573605351
## Type_Wagon -0.23912580  0.2130228868  0.328333276 -0.08351477 -0.135037412
## Cylinder_6 -0.01766147  0.1453881046 -0.321992127 -0.12771959 -0.094204995
## Cylinder_8 -0.15246111  0.0129957971 -0.153193928 -0.10702934  0.025711591
## door_4     -0.14581339  0.0409429019 -0.025680126 -0.06485191 -0.825443521
## Cruise_Y   -0.29318975  0.0009385587  0.233118495 -0.19904373 -0.040645846
## Sound_Y     0.25956627 -0.0743142240 -0.087208644 -0.13937106  0.097838246
## Leather_Y   0.15549200 -0.0898537770  0.003809046 -0.15279447  0.063507235
##             Type_Hatch   Type_Sedan   Type_Wagon  Cylinder_6   Cylinder_8
## Price      -0.20617811 -0.034802255  0.045133860 -0.10117891  0.672419598
## Mileage    -0.02569144 -0.015904640  0.027015682 -0.02595605 -0.011806702
## Sound       0.07354434 -0.015079396 -0.142361646  0.04640653 -0.128453501
## Leather     0.09069703 -0.100940416 -0.003374894 -0.20807061  0.232770889
## Make_Cadi  -0.09439845  0.180930059 -0.097757444 -0.09258868  0.630169480
## Make_Chev   0.34925035 -0.182419859 -0.239125800 -0.01766147 -0.152461105
## Make_Ponti -0.13600219 -0.009279135  0.213022887  0.14538810  0.012995797
## Make_SAAB  -0.11542956 -0.142348181  0.328333276 -0.32199213 -0.153193928
## Make_Sat   -0.08064516  0.033303059 -0.083514769 -0.12771959 -0.107029335
## Type_Coup  -0.13039746 -0.573605351 -0.135037412 -0.09420500  0.025711591
## Type_Hatch  1.00000000 -0.354749975 -0.083514769  0.06676251 -0.107029335
## Type_Sedan -0.35474997  1.000000000 -0.367373092  0.26749259 -0.007302379
## Type_Wagon -0.08351477 -0.367373092  1.000000000 -0.23296544 -0.110837775
## Cylinder_6  0.06676251  0.267492592 -0.232965440  1.00000000 -0.298559602
## Cylinder_8 -0.10702934 -0.007302379 -0.110837775 -0.29855960  1.000000000
## door_4      0.15797260  0.694905631  0.163593763  0.20005808 -0.145214028
## Cruise_Y   -0.26484602  0.125713790 -0.044284954  0.21155661  0.216153624
## Sound_Y     0.07354434 -0.015079396 -0.142361646  0.04640653 -0.128453501
## Leather_Y   0.09069703 -0.100940416 -0.003374894 -0.20807061  0.232770889
##                 door_4      Cruise_Y     Sound_Y    Leather_Y
## Price      -0.13874965  0.4308514933 -0.12434785  0.157196855
## Mileage    -0.01694449  0.0250366519 -0.02614593  0.001005446
## Sound      -0.06253031 -0.0917301515  1.00000000  0.165443625
## Leather    -0.06196858 -0.0705730942  0.16544362  1.000000000
```

```
## Make_Cadi   0.08710393  0.1906446232 -0.09193204  0.205300830
## Make_Chev  -0.14581339 -0.2931897513  0.25956627  0.155492004
## Make_Ponti  0.04094290  0.0009385587 -0.07431422 -0.089853777
## Make_SAAB  -0.02568013  0.2331184953 -0.08720864  0.003809046
## Make_Sat   -0.06485191 -0.1990437304 -0.13937106 -0.152794474
## Type_Coup  -0.82544352 -0.0406458465  0.09783825  0.063507235
## Type_Hatch  0.15797260 -0.2648460163  0.07354434  0.090697030
## Type_Sedan  0.69490563  0.1257137901 -0.01507940 -0.100940416
## Type_Wagon  0.16359376 -0.0442849538 -0.14236165 -0.003374894
## Cylinder_6  0.20005808  0.2115566149  0.04640653 -0.208070612
## Cylinder_8 -0.14521403  0.2161536240 -0.12845350  0.232770889
## door_4      1.00000000 -0.0476741805 -0.06253031 -0.061968579
## Cruise_Y   -0.04767418  1.0000000000 -0.09173015 -0.070573094
## Sound_Y    -0.06253031 -0.0917301515  1.00000000  0.165443625
## Leather_Y  -0.06196858 -0.0705730942  0.16544362  1.000000000
```

Checking the correlation to find the relationship between independent variables, we can observe that: Price is negatively co-related with Mileage, Doors and Sound and positively co-related with Number of cylinders, Cruise and Leather seats.

6. Before running a multiple regression, run a few bivariate regressions of Y on some of your X variables. What do you infer? Which of these do you think might change with the addition of multiple variables?

Ans:

Regressing Mileage on Price:

```
model_1 <- lm(df$Price~df$Mileage, data = df)
summary(model_1)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage, data = df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -13905  -7254  -3520   5188  46091
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.476e+04  9.044e+02  27.383  < 2e-16 ***
## df$Mileage  -1.725e-01  4.215e-02  -4.093 4.68e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9789 on 802 degrees of freedom
## Multiple R-squared:  0.02046,    Adjusted R-squared:  0.01924
## F-statistic: 16.75 on 1 and 802 DF,  p-value: 4.685e-05
```

We can observe that Mileage has a negative effect on price but just marginally (the p-value is very less). We can interpret that 1 unit increase in mileage reduces Price by 0.634 times which is marginal. Further, $R^2$ is very less (0.02) which signifies very little of the variation in Price is captured by Mileage.

Regressing availability of Cruise control on price:

```
model_2 <- lm(df$Price~df$Cruise, data = df)
summary(model_2)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Cruise, data = df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -14913  -6020  -1454   3634  46971
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  13921.9      632.7   22.00   <2e-16 ***
## df$Cruise     9862.3      729.4   13.52   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8926 on 802 degrees of freedom
## Multiple R-squared:  0.1856, Adjusted R-squared:  0.1846
## F-statistic: 182.8 on 1 and 802 DF,  p-value: < 2.2e-16
```

We can observe that having cruise control has a positive effect on price. Having cruise control to not having it affects the Price by 9862$. Further, $R^2$ is very less (0.186) which signifies very little of the variation in Price is captured by Cruise.

Regressing cylinder on Price:

```
model_3 <- lm(df$Price~df$Make_Cadi+df$Make_Chev+df$Make_Ponti+df$Make_SAAB+df$Make_Sat, data = df)
summary(model_3)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Make_Cadi + df$Make_Chev + df$Make_Ponti +
##     df$Make_SAAB + df$Make_Sat, data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -12896.2  -3391.4   -864.6   1721.5  30637.6
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    20815.1      660.8  31.499  < 2e-16 ***
## df$Make_Cadi   20121.2      934.5  21.531  < 2e-16 ***
## df$Make_Chev   -4387.5      738.8  -5.939 4.29e-09 ***
## df$Make_Ponti  -2403.0      818.3  -2.937  0.00341 **
## df$Make_SAAB    8679.6      862.0  10.069  < 2e-16 ***
## df$Make_Sat    -6836.3     1009.4  -6.773 2.46e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5911 on 798 degrees of freedom
## Multiple R-squared:  0.6447, Adjusted R-squared:  0.6425
## F-statistic: 289.6 on 5 and 798 DF,  p-value: < 2.2e-16
```

We can observe that as far as Make of the car is concerned, Cadillac has the most positive effect on price. Cadillac cars have a positive effect on price by $20121 followed by SAAB make Further, $R^2$ is also quite good (0.64) which signifies 64% of the variation in Price is captured by Make of the car.

7. Run your full multiple regression using lm() and present your results using the output from the stargazer

R package. Interpret the coefficients. What do they tell you substantively? Which variables seem to have the biggest substantive impact? Which ones could you actually change with some intervention, and how big a difference do you think that could make?

Ans:

Running the full multiple regression:

```
model_final <- lm(df$Price~., data = df)
summary(model_final)
```

```
##
## Call:
## lm(formula = df$Price ~ ., data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10242.8  -1409.8    137.8   1356.5  13520.0
##
## Coefficients: (3 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.902e+04  7.271e+02  39.904  < 2e-16 ***
## Mileage     -1.855e-01  1.226e-02 -15.128  < 2e-16 ***
## Sound        5.641e+02  2.297e+02   2.455  0.01429 *
## Leather      5.276e+02  2.473e+02   2.133  0.03322 *
## Make_Cadi    1.087e+04  5.539e+02  19.616  < 2e-16 ***
## Make_Chev   -2.112e+03  4.172e+02  -5.061  5.2e-07 ***
## Make_Ponti  -2.825e+03  4.205e+02  -6.719  3.5e-11 ***
## Make_SAAB    1.046e+04  5.314e+02  19.687  < 2e-16 ***
## Make_Sat    -1.711e+03  5.528e+02  -3.095  0.00204 **
## Type_Coup   -1.066e+04  5.321e+02 -20.035  < 2e-16 ***
## Type_Hatch  -1.334e+04  6.258e+02 -21.321  < 2e-16 ***
## Type_Sedan  -1.168e+04  4.744e+02 -24.615  < 2e-16 ***
## Type_Wagon  -7.610e+03  5.799e+02 -13.122  < 2e-16 ***
## Cylinder_6   6.076e+03  2.961e+02  20.521  < 2e-16 ***
## Cylinder_8   1.578e+04  4.783e+02  32.998  < 2e-16 ***
## door_4              NA         NA      NA       NA
## Cruise_Y     5.867e+02  2.915e+02   2.012  0.04451 *
## Sound_Y             NA         NA      NA       NA
## Leather_Y           NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2837 on 788 degrees of freedom
## Multiple R-squared:  0.9192, Adjusted R-squared:  0.9176
## F-statistic: 597.3 on 15 and 788 DF,  p-value: < 2.2e-16
```

```
library(stargazer)
```

```
##
## Please cite as:
##  Hlavac, Marek (2015). stargazer: Well-Formatted Regression and Summary Statistics Tables.
##  R package version 5.2. http://CRAN.R-project.org/package=stargazer
```

```
stargazer(model_final, no.space=TRUE, dep.var.labels=c("Price"),
          covariate.labels=c("Mileage","Make (cadillac)","Make (Chevrolet)","Make (Pontiac)","Make (SAA
```

Table 1:

| | *Dependent variable:* |
|---|---|
| | Price |
| Mileage | $-0.186^{***}$ |
| | (0.012) |
| Make (cadillac) | $564.074^{**}$ |
| | (229.739) |
| Make (Chevrolet) | $527.613^{**}$ |
| | (247.344) |
| Make (Pontiac) | $10{,}865.960^{***}$ |
| | (553.928) |
| Make (SAAB) | $-2{,}111.536^{***}$ |
| | (417.226) |
| Make (Saturn) | $-2{,}825.104^{***}$ |
| | (420.453) |
| Type (Coupe) | $10{,}462.570^{***}$ |
| | (531.441) |
| Type (Hatchback) | $-1{,}710.556^{***}$ |
| | (552.753) |
| Type (Sedan) | $-10{,}660.860^{***}$ |
| | (532.113) |
| Type (Wagon) | $-13{,}343.370^{***}$ |
| | (625.847) |
| Cylinder (6) | $-11{,}678.130^{***}$ |
| | (474.425) |
| Cylinder (8) | $-7{,}609.595^{***}$ |
| | (579.894) |
| Door(4) | $6{,}076.322^{***}$ |
| | (296.106) |
| Cruise(Y) | $15{,}783.300^{***}$ |
| | (478.317) |
| Sound(Y) | |
| Leather(Y) | $586.708^{**}$ |
| | (291.536) |
| Sound_Y | |
| Leather_Y | |
| Constant | $29{,}016.030^{***}$ |
| | (727.149) |
| Observations | 804 |
| $R^2$ | 0.919 |
| Adjusted $R^2$ | 0.918 |
| *Note:* | $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01 |

As, can be observed from the full model regression results: Cars of Make Cadillac and SAAB have a psoitive effect on the price, as also having a c ar which has a 6 or a 8 cylinder has a psotive effect. Also Cars having cruise control, sound and leather seats increase their price values.

The most significant parameter which affects car prices positively is having a 6 cylinder car (USD 121) and a wagon type car has the most detrimental effect.($-152 against not having wagon)

8. How have any of the coefficients changed from the bivariate regressions? What can you infer from that? How do you think your various independent variables interact and affect each other? Try to find an example where a variable appears signficant in the bivariate regression, but not in the full regression. Is this an example of a spurious or a chained causal pathway?

Ans:

```
m1 <- lm(df$Price~df$Mileage, data = df)
summary(m1)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage, data = df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -13905  -7254  -3520   5188  46091
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.476e+04  9.044e+02  27.383  < 2e-16 ***
## df$Mileage  -1.725e-01  4.215e-02  -4.093 4.68e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9789 on 802 degrees of freedom
## Multiple R-squared:  0.02046,    Adjusted R-squared:  0.01924
## F-statistic: 16.75 on 1 and 802 DF,  p-value: 4.685e-05
```

```
m2<- lm(df$Price~df$Mileage+df$Make_Cadi+df$Make_Chev+df$Make_Ponti+df$Make_SAAB+df$Make_Sat, data = df)
summary(m2)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage + df$Make_Cadi + df$Make_Chev +
##     df$Make_Ponti + df$Make_SAAB + df$Make_Sat, data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -11755.2  -3274.0   -701.8   1517.1  28174.1
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.431e+04  8.182e+02  29.705  < 2e-16 ***
## df$Mileage    -1.709e-01  2.481e-02  -6.888 1.15e-11 ***
## df$Make_Cadi   1.986e+04  9.093e+02  21.844  < 2e-16 ***
## df$Make_Chev  -4.520e+03  7.185e+02  -6.290 5.22e-10 ***
## df$Make_Ponti -2.592e+03  7.959e+02  -3.257  0.00117 **
## df$Make_SAAB   8.771e+03  8.381e+02  10.465  < 2e-16 ***
## df$Make_Sat   -6.852e+03  9.813e+02  -6.983 6.10e-12 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5746 on 797 degrees of freedom
## Multiple R-squared:  0.6647, Adjusted R-squared:  0.6621
## F-statistic: 263.3 on 6 and 797 DF,  p-value: < 2.2e-16
```

```
m3 <- lm(df$Price~df$Mileage+df$Make_Cadi+df$Make_Chev+df$Make_Ponti+df$Make_SAAB+df$Make_Sat+df$Cylinde
summary(m3)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage + df$Make_Cadi + df$Make_Chev +
##     df$Make_Ponti + df$Make_SAAB + df$Make_Sat + df$Cylinder_6 +
##     df$Cylinder_8 + df$Cruise_Y + df$Sound_Y + df$Leather_Y,
##     data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -12468.8  -1737.4   -305.6   1521.8  23094.1
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)    1.799e+04  7.481e+02  24.044  < 2e-16 ***
## df$Mileage    -1.801e-01  1.654e-02 -10.887  < 2e-16 ***
## df$Make_Cadi   1.031e+04  7.441e+02  13.850  < 2e-16 ***
## df$Make_Chev  -2.138e+03  5.381e+02  -3.974 7.71e-05 ***
## df$Make_Ponti -2.322e+03  5.567e+02  -4.172 3.35e-05 ***
## df$Make_SAAB   1.410e+04  6.822e+02  20.664  < 2e-16 ***
## df$Make_Sat   -1.880e+03  7.289e+02  -2.579   0.0101 *
## df$Cylinder_6  5.305e+03  3.845e+02  13.798  < 2e-16 ***
## df$Cylinder_8  1.803e+04  6.198e+02  29.098  < 2e-16 ***
## df$Cruise_Y    8.053e+02  3.809e+02   2.114   0.0348 *
## df$Sound_Y     5.367e+02  3.069e+02   1.749   0.0807 .
## df$Leather_Y   9.672e+01  3.319e+02   0.291   0.7708
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3828 on 792 degrees of freedom
## Multiple R-squared:  0.8521, Adjusted R-squared:   0.85
## F-statistic: 414.7 on 11 and 792 DF,  p-value: < 2.2e-16
```

Make of the car Saturn becomes very less significant when additional predictor variables for Cruise, Sound and Leather are added to the regression model. This arises because of a Spurious relationship.

9. How does what you see match, or not, your hypotheses from (4)? Why did/didn't it match what you expected?

Ans:

From my earlier hypothesis that Cadillac Make cars and 8 cylinder cars fetch positive prices is true from the regression models. It matched my hypothesis since thefinal regression model did not show any kind of a spurious/chained effect on the variables.

10. What do the R2 and adjusted R2 tell you about your model?

The $R^2(0.9192)$ and the adjusted $R^2(0.9176)$ suggest are almost same which suggest the model doesnot overfit and the high $R^2$ is just not because of the large number of predictor variables. The high value also signifies

the model has high accuracy and is a good model.

11. How would you use one of the variable selection methods to choose a model with fewer variables? Select one of the methods (either one of the stepwise or criterion-based methods) and show which variables it would lead you to keep. Do you agree with its results?

```
Full_Model_BR <- lm(df$Price~., data = na.omit(df))
step(Full_Model_BR, direction = "backward", trace = F)
```

```
##
## Call:
## lm(formula = df$Price ~ Mileage + Sound + Leather + Make_Cadi +
##     Make_Chev + Make_Ponti + Make_SAAB + Make_Sat + Type_Coup +
##     Type_Hatch + Type_Sedan + Type_Wagon + Cylinder_6 + Cylinder_8 +
##     Cruise_Y, data = na.omit(df))
##
## Coefficients:
## (Intercept)      Mileage        Sound      Leather    Make_Cadi
##   2.902e+04   -1.855e-01    5.641e+02    5.276e+02    1.087e+04
##   Make_Chev   Make_Ponti    Make_SAAB     Make_Sat    Type_Coup
##  -2.112e+03   -2.825e+03    1.046e+04   -1.711e+03   -1.066e+04
##  Type_Hatch   Type_Sedan   Type_Wagon   Cylinder_6   Cylinder_8
##  -1.334e+04   -1.168e+04   -7.610e+03    6.076e+03    1.578e+04
##    Cruise_Y
##   5.867e+02
```

```
summary(Full_Model_BR)
```

```
##
## Call:
## lm(formula = df$Price ~ ., data = na.omit(df))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10242.8  -1409.8    137.8   1356.5  13520.0
##
## Coefficients: (3 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.902e+04  7.271e+02  39.904  < 2e-16 ***
## Mileage     -1.855e-01  1.226e-02 -15.128  < 2e-16 ***
## Sound        5.641e+02  2.297e+02   2.455  0.01429 *
## Leather      5.276e+02  2.473e+02   2.133  0.03322 *
## Make_Cadi    1.087e+04  5.539e+02  19.616  < 2e-16 ***
## Make_Chev   -2.112e+03  4.172e+02  -5.061  5.2e-07 ***
## Make_Ponti  -2.825e+03  4.205e+02  -6.719  3.5e-11 ***
## Make_SAAB    1.046e+04  5.314e+02  19.687  < 2e-16 ***
## Make_Sat    -1.711e+03  5.528e+02  -3.095  0.00204 **
## Type_Coup   -1.066e+04  5.321e+02 -20.035  < 2e-16 ***
## Type_Hatch  -1.334e+04  6.258e+02 -21.321  < 2e-16 ***
## Type_Sedan  -1.168e+04  4.744e+02 -24.615  < 2e-16 ***
## Type_Wagon  -7.610e+03  5.799e+02 -13.122  < 2e-16 ***
## Cylinder_6   6.076e+03  2.961e+02  20.521  < 2e-16 ***
## Cylinder_8   1.578e+04  4.783e+02  32.998  < 2e-16 ***
## door_4              NA         NA      NA       NA
## Cruise_Y     5.867e+02  2.915e+02   2.012  0.04451 *
## Sound_Y             NA         NA      NA       NA
```

```
## Leather_Y           NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2837 on 788 degrees of freedom
## Multiple R-squared:  0.9192, Adjusted R-squared:  0.9176
## F-statistic: 597.3 on 15 and 788 DF,  p-value: < 2.2e-16
```

I have used the backward elimination method to find out the most significant variables. The most important variables are the Mileage, Make and the Type and Cylinder in the vehicle which is close to what we had hypothesized earlier.

12. What are your overall conclusions? What are the weaknesses of your results, and how could you improve them with better or different data?

Ans: I am getting a large number of predictor variables as the significant ones. The high R squared value could be misleading and can actually be due to modeling random noise due to the large number of predictor variables. I believe since the number of significant variables is quite large,it would make great sense to do some variable reduction operation so as to avoid overfitting.

13. Calculations (using R):

a. Derive the coefficients from your regression using the (X'X)???1X'Y formula. (If you run into problems using solve(), try using ginv() instead, which does the same thing but is a bit more robust.)

Ans:

```
model_final <- lm(df$Price~., data = df)
summary(model_final)
```

```
##
## Call:
## lm(formula = df$Price ~ ., data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10242.8  -1409.8    137.8   1356.5  13520.0
##
## Coefficients: (3 not defined because of singularities)
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.902e+04  7.271e+02  39.904  < 2e-16 ***
## Mileage     -1.855e-01  1.226e-02 -15.128  < 2e-16 ***
## Sound        5.641e+02  2.297e+02   2.455  0.01429 *
## Leather      5.276e+02  2.473e+02   2.133  0.03322 *
## Make_Cadi    1.087e+04  5.539e+02  19.616  < 2e-16 ***
## Make_Chev   -2.112e+03  4.172e+02  -5.061  5.2e-07 ***
## Make_Ponti  -2.825e+03  4.205e+02  -6.719  3.5e-11 ***
## Make_SAAB    1.046e+04  5.314e+02  19.687  < 2e-16 ***
## Make_Sat    -1.711e+03  5.528e+02  -3.095  0.00204 **
## Type_Coup   -1.066e+04  5.321e+02 -20.035  < 2e-16 ***
## Type_Hatch  -1.334e+04  6.258e+02 -21.321  < 2e-16 ***
## Type_Sedan  -1.168e+04  4.744e+02 -24.615  < 2e-16 ***
## Type_Wagon  -7.610e+03  5.799e+02 -13.122  < 2e-16 ***
## Cylinder_6   6.076e+03  2.961e+02  20.521  < 2e-16 ***
## Cylinder_8   1.578e+04  4.783e+02  32.998  < 2e-16 ***
## door_4              NA         NA      NA       NA
## Cruise_Y     5.867e+02  2.915e+02   2.012  0.04451 *
## Sound_Y             NA         NA      NA       NA
```

```
## Leather_Y           NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2837 on 788 degrees of freedom
## Multiple R-squared:  0.9192, Adjusted R-squared:  0.9176
## F-statistic: 597.3 on 15 and 788 DF,  p-value: < 2.2e-16
```

Now, lets derive it using matrix algebra, $t(X)$ is R's notation for X' and solve(X) is R's notation for $X^{-1}$.

```
xmat <- as.matrix(cbind(df$Mileage, df$Make_Cadi, df$Make_Chev,df$Make_Ponti, df$Make_SAAB,df$Make_Sat,

xmat <- cbind(1,xmat) # add the column's of 1
head(xmat)
```

```
##      [,1]  [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    1  8221    0    0    0    0    0    0    0     1     0     1     0
## [2,]    1  9135    0    0    0    0    0    0    0     1     0     1     0
## [3,]    1 13196    0    0    0    0    0    0    0     1     0     1     0
## [4,]    1 16342    0    0    0    0    0    0    0     1     0     1     0
## [5,]    1 19832    0    0    0    0    0    0    0     1     0     1     0
## [6,]    1 22236    0    0    0    0    0    0    0     1     0     1     0
##      [,14] [,15] [,16] [,17]
## [1,]     1     1     1     1
## [2,]     1     1     1     0
## [3,]     1     1     1     0
## [4,]     1     1     0     0
## [5,]     1     1     0     1
## [6,]     1     1     1     0
```

```
#now we solve for Beta in one step: (X'X)^-1 X'Y :
library(MASS)
ginv(t(xmat)%*%xmat) %*% t(xmat)%*%df$Price
```

```
##                [,1]
##  [1,] 3.851878e-05
##  [2,] 8.942199e-01
##  [3,] 3.654263e-06
##  [4,] 1.519453e-05
##  [5,] 7.001072e-06
##  [6,] 5.773417e-06
##  [7,] 2.947561e-06
##  [8,] 6.716357e-06
##  [9,] 2.767124e-06
## [10,] 2.335192e-05
## [11,] 3.182509e-06
## [12,] 1.465077e-05
## [13,] 4.728903e-06
## [14,] 2.930156e-05
## [15,] 2.915680e-05
## [16,] 2.596409e-05
## [17,] 2.789015e-05
```

Above are the coefficients obtained by the $X'X^{-1}X'Y$

b. For one of the coefficients, confirm its p value as shown in the regression output using the coefficient,its standard error, and pt() in R.

Ans:

Lets consider the coeeficients of our first regression model: Mileage Vs Price

```
model_1
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage, data = df)
##
## Coefficients:
## (Intercept)   df$Mileage
##  24764.5590      -0.1725
```

```
summary(model_1)
```

```
##
## Call:
## lm(formula = df$Price ~ df$Mileage, data = df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -13905  -7254  -3520   5188  46091
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.476e+04  9.044e+02  27.383  < 2e-16 ***
## df$Mileage  -1.725e-01  4.215e-02  -4.093 4.68e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9789 on 802 degrees of freedom
## Multiple R-squared:  0.02046,    Adjusted R-squared:  0.01924
## F-statistic: 16.75 on 1 and 802 DF,  p-value: 4.685e-05
```

Checking using coefficient, std error and pt() we observe: Here, t statistic=-4.093

```
pt(-4.093,1,802)
```

```
## [1] 0
```

which is very less like (~0.03) our p-value computed above (4.685e-05 = 0.03)

c. Calculate the R2 and adjusted R2 using R, and confirm that your results match the regression output.

Ans:

$R^2 = \frac{TSS-SSE}{TSS}$ $SSE = \sum_i (y_i - \hat{y}_i)^2$ $TSS = \sum_i (y_i - \bar{y})^2$

Computing $R^2$:

```
ypred <- predict(model_final)
# and the rest of it is done as we have done before:
y <- df$Price
tss <- sum((y - mean(y))^2)
sse <- sum((y-ypred)^2)
r2 <- (tss-sse)/tss
r2
```

```
## [1] 0.9191608
```

Computing Adjusted $R^2$: adjusted $R^2 = \frac{TSS/df_t - SSE/df_e}{TSS/df_t}$ where, $df_t = n - 1$ and $df_e = n - k - 1$

```
n <- length(y)
k <- ncol(xmat)-1
dft <- n - 1
dfe <- n - k - 1
(tss/dft - sse/dfe)/ (tss/dft)
```

```
## [1] 0.9175173
```

Yes, both my $R^2 = 0.9191$ and Adjusted $R^2 = 0.9175$ match the regression output.

d. Calulate the F statistic using R and confirm it against the regression output.

Ans: The F statistic for the multiple regression model should look like: $F = \frac{R^2/k}{(1-R^2)/(n-k-1)}$ where the first degree of freedom is $df1 = k$ and the second is $df2 = n???k???1$. So we can calculate our F statistic and the p value directly:

```
f <- (r2/k) / ((1-r2)/(n-k-1))
f
```

```
## [1] 559.2733
```

14. Add at least one quadratic term into your model and interpret the results. Is it significant? What is the effect of a 1-unit increase in that variable at its mean value?

```
Full_Model_2 <- lm(df$Price~ I(Mileage^2)+., data = na.omit(df))
summary(Full_Model_2)
```

```
##
## Call:
## lm(formula = df$Price ~ I(Mileage^2) + ., data = na.omit(df))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10155.8  -1435.5    184.5   1377.4  13215.7
##
## Coefficients: (3 not defined because of singularities)
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.942e+04  7.921e+02  37.137  < 2e-16 ***
## I(Mileage^2)  1.305e-06  1.023e-06   1.276  0.20223
## Mileage      -2.359e-01  4.133e-02  -5.708 1.62e-08 ***
## Sound         5.557e+02  2.297e+02   2.419  0.01579 *
## Leather       5.246e+02  2.473e+02   2.122  0.03417 *
## Make_Cadi     1.083e+04  5.542e+02  19.549  < 2e-16 ***
## Make_Chev    -2.140e+03  4.177e+02  -5.124 3.76e-07 ***
## Make_Ponti   -2.852e+03  4.208e+02  -6.777 2.40e-11 ***
## Make_SAAB     1.043e+04  5.318e+02  19.619  < 2e-16 ***
## Make_Sat     -1.745e+03  5.532e+02  -3.154  0.00167 **
## Type_Coup    -1.062e+04  5.327e+02 -19.941  < 2e-16 ***
## Type_Hatch   -1.329e+04  6.271e+02 -21.187  < 2e-16 ***
## Type_Sedan   -1.165e+04  4.746e+02 -24.551  < 2e-16 ***
## Type_Wagon   -7.563e+03  5.808e+02 -13.020  < 2e-16 ***
## Cylinder_6    6.077e+03  2.960e+02  20.532  < 2e-16 ***
## Cylinder_8    1.578e+04  4.781e+02  32.997  < 2e-16 ***
## door_4               NA         NA      NA       NA
## Cruise_Y      5.881e+02  2.914e+02   2.018  0.04394 *
## Sound_Y              NA         NA      NA       NA
```

```
## Leather_Y            NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2836 on 787 degrees of freedom
## Multiple R-squared:  0.9193, Adjusted R-squared:  0.9177
## F-statistic: 560.5 on 16 and 787 DF,  p-value: < 2.2e-16
```

```
xbar <- mean(df$Mileage)
y1 <- Full_Model_2$coefficients[3]*xbar + Full_Model_2$coefficients[2] * xbar^2
y2 <- Full_Model_2$coefficients[3]*(xbar+1) + Full_Model_2$coefficients[2]*(xbar+1)^2
y2 - y1
```

```
##    Mileage
## -0.1841533
```

Hence, the quadratic term is insignificant as 1-unit increase in the quadratic term changes y be -0.184 when other variables are held constant.

15. Add at least one interaction term to you model and interpret the results. Is it significant? What is the effect of a 1-unit increase in one of those interacted variables holding the other at its mean value?

Ans:

```
Full_Model_3 <- lm(df$Price~ Mileage*Cylinder_8+., data = na.omit(df))
summary(Full_Model_3)
```

```
##
## Call:
## lm(formula = df$Price ~ Mileage * Cylinder_8 + ., data = na.omit(df))
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -10725  -1472     94   1333  11090
##
## Coefficients: (3 not defined because of singularities)
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)          2.826e+04  7.163e+02  39.457  < 2e-16 ***
## Mileage             -1.521e-01  1.293e-02 -11.761  < 2e-16 ***
## Cylinder_8           2.025e+04  8.107e+02  24.978  < 2e-16 ***
## Sound                5.608e+02  2.235e+02   2.509  0.01232 *
## Leather              5.297e+02  2.407e+02   2.201  0.02805 *
## Make_Cadi            1.085e+04  5.390e+02  20.138  < 2e-16 ***
## Make_Chev           -2.108e+03  4.060e+02  -5.192 2.65e-07 ***
## Make_Ponti          -2.719e+03  4.094e+02  -6.642 5.78e-11 ***
## Make_SAAB            1.048e+04  5.171e+02  20.271  < 2e-16 ***
## Make_Sat            -1.712e+03  5.379e+02  -3.182  0.00152 **
## Type_Coup           -1.060e+04  5.178e+02 -20.470  < 2e-16 ***
## Type_Hatch          -1.323e+04  6.092e+02 -21.709  < 2e-16 ***
## Type_Sedan          -1.159e+04  4.618e+02 -25.096  < 2e-16 ***
## Type_Wagon          -7.599e+03  5.643e+02 -13.468  < 2e-16 ***
## Cylinder_6           6.069e+03  2.881e+02  21.062  < 2e-16 ***
## door_4                      NA         NA      NA       NA
## Cruise_Y             5.757e+02  2.837e+02   2.029  0.04277 *
## Sound_Y                     NA         NA      NA       NA
## Leather_Y                   NA         NA      NA       NA
## Mileage:Cylinder_8 -2.267e-01  3.370e-02  -6.728 3.31e-11 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2761 on 787 degrees of freedom
## Multiple R-squared:  0.9236, Adjusted R-squared:  0.922
## F-statistic: 594.3 on 16 and 787 DF,  p-value: < 2.2e-16
```

```
mean_Cylinder_8 <- mean(df$Cylinder_8)
mean_Mileage <- mean(df$Mileage)
y1 <- Full_Model_3$coefficients[2]*mean_Mileage + Full_Model_3$coefficients[20]*mean_Mileage*mean_Cylin
y2 <- Full_Model_3$coefficients[2]*(mean_Mileage+1) +
Full_Model_3$coefficients[20]*(mean_Mileage+1)*mean_Cylinder_8
y2 - y1
```

```
##    Mileage
## -0.1802695
```

The interaction term is not significant. There is a decrease of -0.18 in y with a 1 unit increase in Mileage holding interaction tern at mean and other independent variables constant.

16. Test either the model in 14 or the model in 15 using the F test for nested models. That is, estimate the full model with the variable and quadratic term, or the variable and interaction, and then estimate the reduced model without either, and run the F test to establish whether those variables significantly your model.

Ans:

```
anova(model_final, Full_Model_3)
```

```
## Analysis of Variance Table
##
## Model 1: df$Price ~ Mileage + Sound + Leather + Make_Cadi + Make_Chev +
##     Make_Ponti + Make_SAAB + Make_Sat + Type_Coup + Type_Hatch +
##     Type_Sedan + Type_Wagon + Cylinder_6 + Cylinder_8 + door_4 +
##     Cruise_Y + Sound_Y + Leather_Y
## Model 2: df$Price ~ Mileage * Cylinder_8 + (Mileage + Sound + Leather +
##     Make_Cadi + Make_Chev + Make_Ponti + Make_SAAB + Make_Sat +
##     Type_Coup + Type_Hatch + Type_Sedan + Type_Wagon + Cylinder_6 +
##     Cylinder_8 + door_4 + Cruise_Y + Sound_Y + Leather_Y)
##   Res.Df        RSS Df Sum of Sq      F   Pr(>F)
## 1    788 6342757374
## 2    787 5997781969  1 344975405 45.266 3.31e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Looking at the p-value, we reject the Null hypothesis.