Advanced DM Assignment One final

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```
library(ISLR)
```

```
## Warning: package 'ISLR' was built under R version 4.2.2
```

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(glmnet)
```

```
## Warning: package 'glmnet' was built under R version 4.2.2

## Loading required package: Matrix

## Warning: package 'Matrix' was built under R version 4.2.2

## Loaded glmnet 4.1-6
```

```
library(caret)
```

```
## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.2.2

## Loading required package: lattice
```

```
Carseats <- read.csv("dataset_car_seats.csv")
Carseats
```

```
##       X Sales CompPrice Income Advertising Population Price ShelveLoc Age
## 1     0  9.50       138     73           11        276   120       Bad  42
## 2     1 11.22       111     48           16        260    83      Good  65
## 3     2 10.06       113     35           10        269    80    Medium  59
## 4     3  7.40       117    100            4        466    97    Medium  55
## 5     4  4.15       141     64            3        340   128       Bad  38
## 6     5 10.81       124    113           13        501    72       Bad  78
## 7     6  6.63       115    105            0         45   108    Medium  71
## 8     7 11.85       136     81           15        425   120      Good  67
## 9     8  6.54       132    110            0        108   124    Medium  76
## 10    9  4.69       132    113            0        131   124    Medium  76
## 11   10  9.01       121     78            9        150   100       Bad  26
## 12   11 11.96       117     94            4        503    94      Good  50
## 13   12  3.98       122     35            2        393   136    Medium  62
## 14   13 10.96       115     28           11         29    86      Good  53
## 15   14 11.17       107    117           11        148   118      Good  52
## 16   15  8.71       149     95            5        400   144    Medium  76
## 17   16  7.58       118     32            0        284   110      Good  63
## 18   17 12.29       147     74           13        251   131      Good  52
## 19   18 13.91       110    110            0        408    68      Good  46
## 20   19  8.73       129     76           16         58   121    Medium  69
## 21   20  6.41       125     90            2        367   131    Medium  35
## 22   21 12.13       134     29           12        239   109      Good  62
## 23   22  5.08       128     46            6        497   138    Medium  42
## 24   23  5.87       121     31            0        292   109    Medium  79
## 25   24 10.14       145    119           16        294   113       Bad  42
## 26   25 14.90       139     32            0        176    82      Good  54
## 27   26  8.33       107    115           11        496   131      Good  50
## 28   27  5.27        98    118            0         19   107    Medium  64
## 29   28  2.99       103     74            0        359    97       Bad  55
## 30   29  7.81       104     99           15        226   102       Bad  58
## 31   30 13.55       125     94            0        447    89      Good  30
## 32   31  8.25       136     58           16        241   131    Medium  44
## 33   32  6.20       107     32           12        236   137      Good  64
## 34   33  8.77       114     38           13        317   128      Good  50
## 35   34  2.67       115     54            0        406   128    Medium  42
## 36   35 11.07       131     84           11         29    96    Medium  44
## 37   36  8.89       122     76            0        270   100      Good  60
## 38   37  4.95       121     41            5        412   110    Medium  54
## 39   38  6.59       109     73            0        454   102    Medium  65
## 40   39  3.24       130     60            0        144   138       Bad  38
## 41   40  2.07       119     98            0         18   126       Bad  73
## 42   41  7.96       157     53            0        403   124       Bad  58
## 43   42 10.43        77     69            0         25    24    Medium  50
## 44   43  4.12       123     42           11         16   134    Medium  59
## 45   44  4.16        85     79            6        325    95    Medium  69
## 46   45  4.56       141     63            0        168   135       Bad  44
## 47   46 12.44       127     90           14         16    70    Medium  48
## 48   47  4.38       126     98            0        173   108       Bad  55
## 49   48  3.91       116     52            0        349    98       Bad  69
```

```
## 50   49 10.61       157     93           0         51   149      Good  32
## 51   50  1.42        99     32          18        341   108       Bad  80
## 52   51  4.42       121     90           0        150   108       Bad  75
## 53   52  7.91       153     40           3        112   129       Bad  39
## 54   53  6.92       109     64          13         39   119    Medium  61
## 55   54  4.90       134    103          13         25   144    Medium  76
## 56   55  6.85       143     81           5         60   154    Medium  61
## 57   56 11.91       133     82           0         54    84    Medium  50
## 58   57  0.91        93     91           0         22   117       Bad  75
## 59   58  5.42       103     93          15        188   103       Bad  74
## 60   59  5.21       118     71           4        148   114    Medium  80
## 61   60  8.32       122    102          19        469   123       Bad  29
## 62   61  7.32       105     32           0        358   107    Medium  26
## 63   62  1.82       139     45           0        146   133       Bad  77
## 64   63  8.47       119     88          10        170   101    Medium  61
## 65   64  7.80       100     67          12        184   104    Medium  32
## 66   65  4.90       122     26           0        197   128    Medium  55
## 67   66  8.85       127     92           0        508    91    Medium  56
## 68   67  9.01       126     61          14        152   115    Medium  47
## 69   68 13.39       149     69          20        366   134      Good  60
## 70   69  7.99       127     59           0        339    99    Medium  65
## 71   70  9.46        89     81          15        237    99      Good  74
## 72   71  6.50       148     51          16        148   150    Medium  58
## 73   72  5.52       115     45           0        432   116    Medium  25
## 74   73 12.61       118     90          10         54   104      Good  31
## 75   74  6.20       150     68           5        125   136    Medium  64
## 76   75  8.55        88    111          23        480    92       Bad  36
## 77   76 10.64       102     87          10        346    70    Medium  64
## 78   77  7.70       118     71          12         44    89    Medium  67
## 79   78  4.43       134     48           1        139   145    Medium  65
## 80   79  9.14       134     67           0        286    90       Bad  41
## 81   80  8.01       113    100          16        353    79       Bad  68
## 82   81  7.52       116     72           0        237   128      Good  70
## 83   82 11.62       151     83           4        325   139      Good  28
## 84   83  4.42       109     36           7        468    94       Bad  56
## 85   84  2.23       111     25           0         52   121       Bad  43
## 86   85  8.47       125    103           0        304   112    Medium  49
## 87   86  8.70       150     84           9        432   134    Medium  64
## 88   87 11.70       131     67           7        272   126      Good  54
## 89   88  6.56       117     42           7        144   111    Medium  62
## 90   89  7.95       128     66           3        493   119    Medium  45
## 91   90  5.33       115     22           0        491   103    Medium  64
## 92   91  4.81        97     46          11        267   107    Medium  80
## 93   92  4.53       114    113           0         97   125    Medium  29
## 94   93  8.86       145     30           0         67   104    Medium  55
## 95   94  8.39       115     97           5        134    84       Bad  55
## 96   95  5.58       134     25          10        237   148    Medium  59
## 97   96  9.48       147     42          10        407   132      Good  73
## 98   97  7.45       161     82           5        287   129       Bad  33
## 99   98 12.49       122     77          24        382   127      Good  36
## 100  99  4.88       121     47           3        220   107       Bad  56
## 101 100  4.11       113     69          11         94   106    Medium  76
## 102 101  6.20       128     93           0         89   118    Medium  34
## 103 102  5.30       113     22           0         57    97    Medium  65
```

```
## 104 103  5.07       123     91           0       334    96       Bad  78
## 105 104  4.62       121     96           0       472   138    Medium  51
## 106 105  5.55       104    100           8       398    97    Medium  61
## 107 106  0.16       102     33           0       217   139    Medium  70
## 108 107  8.55       134    107           0       104   108    Medium  60
## 109 108  3.47       107     79           2       488   103       Bad  65
## 110 109  8.98       115     65           0       217    90    Medium  60
## 111 110  9.00       128     62           7       125   116    Medium  43
## 112 111  6.62       132    118          12       272   151    Medium  43
## 113 112  6.67       116     99           5       298   125      Good  62
## 114 113  6.01       131     29          11       335   127       Bad  33
## 115 114  9.31       122     87           9        17   106    Medium  65
## 116 115  8.54       139     35           0        95   129    Medium  42
## 117 116  5.08       135     75           0       202   128    Medium  80
## 118 117  8.80       145     53           0       507   119    Medium  41
## 119 118  7.57       112     88           2       243    99    Medium  62
## 120 119  7.37       130     94           8       137   128    Medium  64
## 121 120  6.87       128    105          11       249   131    Medium  63
## 122 121 11.67       125     89          10       380    87       Bad  28
## 123 122  6.88       119    100           5        45   108    Medium  75
## 124 123  8.19       127    103           0       125   155      Good  29
## 125 124  8.87       131    113           0       181   120      Good  63
## 126 125  9.34        89     78           0       181    49    Medium  43
## 127 126 11.27       153     68           2        60   133      Good  59
## 128 127  6.52       125     48           3       192   116    Medium  51
## 129 128  4.96       133    100           3       350   126       Bad  55
## 130 129  4.47       143    120           7       279   147       Bad  40
## 131 130  8.41        94     84          13       497    77    Medium  51
## 132 131  6.50       108     69           3       208    94    Medium  77
## 133 132  9.54       125     87           9       232   136      Good  72
## 134 133  7.62       132     98           2       265    97       Bad  62
## 135 134  3.67       132     31           0       327   131    Medium  76
## 136 135  6.44        96     94          14       384   120    Medium  36
## 137 136  5.17       131     75           0        10   120       Bad  31
## 138 137  6.52       128     42           0       436   118    Medium  80
## 139 138 10.27       125    103          12       371   109    Medium  44
## 140 139 12.30       146     62          10       310    94    Medium  30
## 141 140  6.03       133     60          10       277   129    Medium  45
## 142 141  6.53       140     42           0       331   131       Bad  28
## 143 142  7.44       124     84           0       300   104    Medium  77
## 144 143  0.53       122     88           7        36   159       Bad  28
## 145 144  9.09       132     68           0       264   123      Good  34
## 146 145  8.77       144     63          11        27   117    Medium  47
## 147 146  3.90       114     83           0       412   131       Bad  39
## 148 147 10.51       140     54           9       402   119      Good  41
## 149 148  7.56       110    119           0       384    97    Medium  72
## 150 149 11.48       121    120          13       140    87    Medium  56
## 151 150 10.49       122     84           8       176   114      Good  57
## 152 151 10.77       111     58          17       407   103      Good  75
## 153 152  7.64       128     78           0       341   128      Good  45
## 154 153  5.93       150     36           7       488   150    Medium  25
## 155 154  6.89       129     69          10       289   110    Medium  50
## 156 155  7.71        98     72           0        59    69    Medium  65
## 157 156  7.49       146     34           0       220   157      Good  51
```

```
## 158 157 10.21       121     58           8       249    90    Medium  48
## 159 158 12.53       142     90           1       189   112      Good  39
## 160 159  9.32       119     60           0       372    70       Bad  30
## 161 160  4.67       111     28           0       486   111    Medium  29
## 162 161  2.93       143     21           5        81   160    Medium  67
## 163 162  3.63       122     74           0       424   149    Medium  51
## 164 163  5.68       130     64           0        40   106       Bad  39
## 165 164  8.22       148     64           0        58   141    Medium  27
## 166 165  0.37       147     58           7       100   191       Bad  27
## 167 166  6.71       119     67          17       151   137    Medium  55
## 168 167  6.71       106     73           0       216    93    Medium  60
## 169 168  7.30       129     89           0       425   117    Medium  45
## 170 169 11.48       104     41          15       492    77      Good  73
## 171 170  8.01       128     39          12       356   118    Medium  71
## 172 171 12.49        93    106          12       416    55    Medium  75
## 173 172  9.03       104    102          13       123   110      Good  35
## 174 173  6.38       135     91           5       207   128    Medium  66
## 175 174  0.00       139     24           0       358   185    Medium  79
## 176 175  7.54       115     89           0        38   122    Medium  25
## 177 176  5.61       138    107           9       480   154    Medium  47
## 178 177 10.48       138     72           0       148    94    Medium  27
## 179 178 10.66       104     71          14        89    81    Medium  25
## 180 179  7.78       144     25           3        70   116    Medium  77
## 181 180  4.94       137    112          15       434   149       Bad  66
## 182 181  7.43       121     83           0        79    91    Medium  68
## 183 182  4.74       137     60           4       230   140       Bad  25
## 184 183  5.32       118     74           6       426   102    Medium  80
## 185 184  9.95       132     33           7        35    97    Medium  60
## 186 185 10.07       130    100          11       449   107    Medium  64
## 187 186  8.68       120     51           0        93    86    Medium  46
## 188 187  6.03       117     32           0       142    96       Bad  62
## 189 188  8.07       116     37           0       426    90    Medium  76
## 190 189 12.11       118    117          18       509   104    Medium  26
## 191 190  8.79       130     37          13       297   101    Medium  37
## 192 191  6.67       156     42          13       170   173      Good  74
## 193 192  7.56       108     26           0       408    93    Medium  56
## 194 193 13.28       139     70           7        71    96      Good  61
## 195 194  7.23       112     98          18       481   128    Medium  45
## 196 195  4.19       117     93           4       420   112       Bad  66
## 197 196  4.10       130     28           6       410   133       Bad  72
## 198 197  2.52       124     61           0       333   138    Medium  76
## 199 198  3.62       112     80           5       500   128    Medium  69
## 200 199  6.42       122     88           5       335   126    Medium  64
## 201 200  5.56       144     92           0       349   146    Medium  62
## 202 201  5.94       138     83           0       139   134    Medium  54
## 203 202  4.10       121     78           4       413   130       Bad  46
## 204 203  2.05       131     82           0       132   157       Bad  25
## 205 204  8.74       155     80           0       237   124    Medium  37
## 206 205  5.68       113     22           1       317   132    Medium  28
## 207 206  4.97       162     67           0        27   160    Medium  77
## 208 207  8.19       111    105           0       466    97       Bad  61
## 209 208  7.78        86     54           0       497    64       Bad  33
## 210 209  3.02        98     21          11       326    90       Bad  76
## 211 210  4.36       125     41           2       357   123       Bad  47
```

```
## 212 211  9.39       117    118          14        445   120    Medium  32
## 213 212 12.04       145     69          19        501   105    Medium  45
## 214 213  8.23       149     84           5        220   139    Medium  33
## 215 214  4.83       115    115           3         48   107    Medium  73
## 216 215  2.34       116     83          15        170   144       Bad  71
## 217 216  5.73       141     33           0        243   144    Medium  34
## 218 217  4.34       106     44           0        481   111    Medium  70
## 219 218  9.70       138     61          12        156   120    Medium  25
## 220 219 10.62       116     79          19        359   116      Good  58
## 221 220 10.59       131    120          15        262   124    Medium  30
## 222 221  6.43       124     44           0        125   107    Medium  80
## 223 222  7.49       136    119           6        178   145    Medium  35
## 224 223  3.45       110     45           9        276   125    Medium  62
## 225 224  4.10       134     82           0        464   141    Medium  48
## 226 225  6.68       107     25           0        412    82       Bad  36
## 227 226  7.80       119     33           0        245   122      Good  56
## 228 227  8.69       113     64          10         68   101    Medium  57
## 229 228  5.40       149     73          13        381   163       Bad  26
## 230 229 11.19        98    104           0        404    72    Medium  27
## 231 230  5.16       115     60           0        119   114       Bad  38
## 232 231  8.09       132     69           0        123   122    Medium  27
## 233 232 13.14       137     80          10         24   105      Good  61
## 234 233  8.65       123     76          18        218   120    Medium  29
## 235 234  9.43       115     62          11        289   129      Good  56
## 236 235  5.53       126     32           8         95   132    Medium  50
## 237 236  9.32       141     34          16        361   108    Medium  69
## 238 237  9.62       151     28           8        499   135    Medium  48
## 239 238  7.36       121     24           0        200   133      Good  73
## 240 239  3.89       123    105           0        149   118       Bad  62
## 241 240 10.31       159     80           0        362   121    Medium  26
## 242 241 12.01       136     63           0        160    94    Medium  38
## 243 242  4.68       124     46           0        199   135    Medium  52
## 244 243  7.82       124     25          13         87   110    Medium  57
## 245 244  8.78       130     30           0        391   100    Medium  26
## 246 245 10.00       114     43           0        199    88      Good  57
## 247 246  6.90       120     56          20        266    90       Bad  78
## 248 247  5.04       123    114           0        298   151       Bad  34
## 249 248  5.36       111     52           0         12   101    Medium  61
## 250 249  5.05       125     67           0         86   117       Bad  65
## 251 250  9.16       137    105          10        435   156      Good  72
## 252 251  3.72       139    111           5        310   132       Bad  62
## 253 252  8.31       133     97           0         70   117    Medium  32
## 254 253  5.64       124     24           5        288   122    Medium  57
## 255 254  9.58       108    104          23        353   129      Good  37
## 256 255  7.71       123     81           8        198    81       Bad  80
## 257 256  4.20       147     40           0        277   144    Medium  73
## 258 257  8.67       125     62          14        477   112    Medium  80
## 259 258  3.47       108     38           0        251    81       Bad  72
## 260 259  5.12       123     36          10        467   100       Bad  74
## 261 260  7.67       129    117           8        400   101       Bad  36
## 262 261  5.71       121     42           4        188   118    Medium  54
## 263 262  6.37       120     77          15         86   132    Medium  48
## 264 263  7.77       116     26           6        434   115    Medium  25
## 265 264  6.95       128     29           5        324   159      Good  31
```

```
## 266 265  5.31       130     35          10        402   129       Bad  39
## 267 266  9.10       128     93          12        343   112      Good  73
## 268 267  5.83       134     82           7        473   112       Bad  51
## 269 268  6.53       123     57           0         66   105    Medium  39
## 270 269  5.01       159     69           0        438   166    Medium  46
## 271 270 11.99       119     26           0        284    89      Good  26
## 272 271  4.55       111     56           0        504   110    Medium  62
## 273 272 12.98       113     33           0         14    63      Good  38
## 274 273 10.04       116    106           8        244    86    Medium  58
## 275 274  7.22       135     93           2         67   119    Medium  34
## 276 275  6.67       107    119          11        210   132    Medium  53
## 277 276  6.93       135     69          14        296   130    Medium  73
## 278 277  7.80       136     48          12        326   125    Medium  36
## 279 278  7.22       114    113           2        129   151      Good  40
## 280 279  3.42       141     57          13        376   158    Medium  64
## 281 280  2.86       121     86          10        496   145       Bad  51
## 282 281 11.19       122     69           7        303   105      Good  45
## 283 282  7.74       150     96           0         80   154      Good  61
## 284 283  5.36       135    110           0        112   117    Medium  80
## 285 284  6.97       106     46          11        414    96       Bad  79
## 286 285  7.60       146     26          11        261   131    Medium  39
## 287 286  7.53       117    118          11        429   113    Medium  67
## 288 287  6.88        95     44           4        208    72       Bad  44
## 289 288  6.98       116     40           0         74    97    Medium  76
## 290 289  8.75       143     77          25        448   156    Medium  43
## 291 290  9.49       107    111          14        400   103    Medium  41
## 292 291  6.64       118     70           0        106    89       Bad  39
## 293 292 11.82       113     66          16        322    74      Good  76
## 294 293 11.28       123     84           0         74    89      Good  59
## 295 294 12.66       148     76           3        126    99      Good  60
## 296 295  4.21       118     35          14        502   137    Medium  79
## 297 296  8.21       127     44          13        160   123      Good  63
## 298 297  3.07       118     83          13        276   104       Bad  75
## 299 298 10.98       148     63           0        312   130      Good  63
## 300 299  9.40       135     40          17        497    96    Medium  54
## 301 300  8.57       116     78           1        158    99    Medium  45
## 302 301  7.41        99     93           0        198    87    Medium  57
## 303 302  5.28       108     77          13        388   110       Bad  74
## 304 303 10.01       133     52          16        290    99    Medium  43
## 305 304 11.93       123     98          12        408   134      Good  29
## 306 305  8.03       115     29          26        394   132    Medium  33
## 307 306  4.78       131     32           1         85   133    Medium  48
## 308 307  5.90       138     92           0         13   120       Bad  61
## 309 308  9.24       126     80          19        436   126    Medium  52
## 310 309 11.18       131    111          13         33    80       Bad  68
## 311 310  9.53       175     65          29        419   166    Medium  53
## 312 311  6.15       146     68          12        328   132       Bad  51
## 313 312  6.80       137    117           5        337   135       Bad  38
## 314 313  9.33       103     81           3        491    54    Medium  66
## 315 314  7.72       133     33          10        333   129      Good  71
## 316 315  6.39       131     21           8        220   171      Good  29
## 317 316 15.63       122     36           5        369    72      Good  35
## 318 317  6.41       142     30           0        472   136      Good  80
## 319 318 10.08       116     72          10        456   130      Good  41
```

```
## 320 319  6.97       127     45          19        459   129    Medium  57
## 321 320  5.86       136     70          12        171   152    Medium  44
## 322 321  7.52       123     39           5        499    98    Medium  34
## 323 322  9.16       140     50          10        300   139      Good  60
## 324 323 10.36       107    105          18        428   103    Medium  34
## 325 324  2.66       136     65           4        133   150       Bad  53
## 326 325 11.70       144     69          11        131   104    Medium  47
## 327 326  4.69       133     30           0        152   122    Medium  53
## 328 327  6.23       112     38          17        316   104    Medium  80
## 329 328  3.15       117     66           1         65   111       Bad  55
## 330 329 11.27       100     54           9        433    89      Good  45
## 331 330  4.99       122     59           0        501   112       Bad  32
## 332 331 10.10       135     63          15        213   134    Medium  32
## 333 332  5.74       106     33          20        354   104    Medium  61
## 334 333  5.87       136     60           7        303   147    Medium  41
## 335 334  7.63        93    117           9        489    83       Bad  42
## 336 335  6.18       120     70          15        464   110    Medium  72
## 337 336  5.17       138     35           6         60   143       Bad  28
## 338 337  8.61       130     38           0        283   102    Medium  80
## 339 338  5.97       112     24           0        164   101    Medium  45
## 340 339 11.54       134     44           4        219   126      Good  44
## 341 340  7.50       140     29           0        105    91       Bad  43
## 342 341  7.38        98    120           0        268    93    Medium  72
## 343 342  7.81       137    102          13        422   118    Medium  71
## 344 343  5.99       117     42          10        371   121       Bad  26
## 345 344  8.43       138     80           0        108   126      Good  70
## 346 345  4.81       121     68           0        279   149      Good  79
## 347 346  8.97       132    107           0        144   125    Medium  33
## 348 347  6.88        96     39           0        161   112      Good  27
## 349 348 12.57       132    102          20        459   107      Good  49
## 350 349  9.32       134     27          18        467    96    Medium  49
## 351 350  8.64       111    101          17        266    91    Medium  63
## 352 351 10.44       124    115          16        458   105    Medium  62
## 353 352 13.44       133    103          14        288   122      Good  61
## 354 353  9.45       107     67          12        430    92    Medium  35
## 355 354  5.30       133     31           1         80   145    Medium  42
## 356 355  7.02       130    100           0        306   146      Good  42
## 357 356  3.58       142    109           0        111   164      Good  72
## 358 357 13.36       103     73           3        276    72    Medium  34
## 359 358  4.17       123     96          10         71   118       Bad  69
## 360 359  3.13       130     62          11        396   130       Bad  66
## 361 360  8.77       118     86           7        265   114      Good  52
## 362 361  8.68       131     25          10        183   104    Medium  56
## 363 362  5.25       131     55           0         26   110       Bad  79
## 364 363 10.26       111     75           1        377   108      Good  25
## 365 364 10.50       122     21          16        488   131      Good  30
## 366 365  6.53       154     30           0        122   162    Medium  57
## 367 366  5.98       124     56          11        447   134    Medium  53
## 368 367 14.37        95    106           0        256    53      Good  52
## 369 368 10.71       109     22          10        348    79      Good  74
## 370 369 10.26       135    100          22        463   122    Medium  36
## 371 370  7.68       126     41          22        403   119       Bad  42
## 372 371  9.08       152     81           0        191   126    Medium  54
## 373 372  7.80       121     50           0        508    98    Medium  65
```

```
## 374 373  5.58       137     71           0        402   116    Medium  78
## 375 374  9.44       131     47           7         90   118    Medium  47
## 376 375  7.90       132     46           4        206   124    Medium  73
## 377 376 16.27       141     60          19        319    92      Good  44
## 378 377  6.81       132     61           0        263   125    Medium  41
## 379 378  6.11       133     88           3        105   119    Medium  79
## 380 379  5.81       125    111           0        404   107       Bad  54
## 381 380  9.64       106     64          10         17    89    Medium  68
## 382 381  3.90       124     65          21        496   151       Bad  77
## 383 382  4.95       121     28          19        315   121    Medium  66
## 384 383  9.35        98    117           0         76    68    Medium  63
## 385 384 12.85       123     37          15        348   112      Good  28
## 386 385  5.87       131     73          13        455   132    Medium  62
## 387 386  5.32       152    116           0        170   160    Medium  39
## 388 387  8.67       142     73          14        238   115    Medium  73
## 389 388  8.14       135     89          11        245    78       Bad  79
## 390 389  8.44       128     42           8        328   107    Medium  35
## 391 390  5.47       108     75           9         61   111    Medium  67
## 392 391  6.10       153     63           0         49   124       Bad  56
## 393 392  4.53       129     42          13        315   130       Bad  34
## 394 393  5.57       109     51          10         26   120    Medium  30
## 395 394  5.35       130     58          19        366   139       Bad  33
## 396 395 12.57       138    108          17        203   128      Good  33
## 397 396  6.14       139     23           3         37   120    Medium  55
## 398 397  7.41       162     26          12        368   159    Medium  40
## 399 398  5.94       100     79           7        284    95       Bad  50
## 400 399  9.71       134     37           0         27   120      Good  49
##     Education Urban  US
## 1          17   Yes Yes
## 2          10   Yes Yes
## 3          12   Yes Yes
## 4          14   Yes Yes
## 5          13   Yes  No
## 6          16    No Yes
## 7          15   Yes  No
## 8          10   Yes Yes
## 9          10    No  No
## 10         17    No Yes
## 11         10    No Yes
## 12         13   Yes Yes
## 13         18   Yes  No
## 14         18   Yes Yes
## 15         18   Yes Yes
## 16         18    No  No
## 17         13   Yes  No
## 18         10   Yes Yes
## 19         17    No Yes
## 20         12   Yes Yes
## 21         18   Yes Yes
## 22         18    No Yes
## 23         13   Yes  No
## 24         10   Yes  No
## 25         12   Yes Yes
## 26         11    No  No
```

```
## 27         11    No Yes
## 28         17   Yes  No
## 29         11   Yes Yes
## 30         17   Yes Yes
## 31         12   Yes  No
## 32         18   Yes Yes
## 33         10    No Yes
## 34         16   Yes Yes
## 35         17   Yes Yes
## 36         17    No Yes
## 37         18    No  No
## 38         10   Yes Yes
## 39         15   Yes  No
## 40         10    No  No
## 41         17    No  No
## 42         16   Yes  No
## 43         18   Yes  No
## 44         13   Yes Yes
## 45         13   Yes Yes
## 46         12   Yes Yes
## 47         15    No Yes
## 48         16   Yes  No
## 49         18   Yes  No
## 50         17   Yes  No
## 51         16   Yes Yes
## 52         16   Yes  No
## 53         18   Yes Yes
## 54         17   Yes Yes
## 55         17    No Yes
## 56         18   Yes Yes
## 57         17   Yes  No
## 58         11   Yes  No
## 59         16   Yes Yes
## 60         13   Yes  No
## 61         13   Yes Yes
## 62         13    No  No
## 63         17   Yes Yes
## 64         13   Yes Yes
## 65         16    No Yes
## 66         13    No  No
## 67         18   Yes  No
## 68         16   Yes Yes
## 69         13   Yes Yes
## 70         12   Yes  No
## 71         12   Yes Yes
## 72         17    No Yes
## 73         15   Yes  No
## 74         11    No Yes
## 75         13    No Yes
## 76         16    No Yes
## 77         15   Yes Yes
## 78         18    No Yes
## 79         12   Yes Yes
## 80         13   Yes  No
```

```
## 81         11   Yes Yes
## 82         13   Yes  No
## 83         17   Yes Yes
## 84         11   Yes Yes
## 85         18    No  No
## 86         13    No  No
## 87         15   Yes  No
## 88         16    No Yes
## 89         10   Yes Yes
## 90         16    No  No
## 91         11    No  No
## 92         15   Yes Yes
## 93         12   Yes  No
## 94         17   Yes  No
## 95         11   Yes Yes
## 96         13   Yes Yes
## 97         16    No Yes
## 98         16   Yes Yes
## 99         16    No Yes
## 100        16    No Yes
## 101        12    No Yes
## 102        18   Yes  No
## 103        16    No  No
## 104        17   Yes Yes
## 105        12   Yes  No
## 106        11   Yes Yes
## 107        18    No  No
## 108        12   Yes  No
## 109        16   Yes  No
## 110        17    No  No
## 111        14   Yes Yes
## 112        14   Yes Yes
## 113        12   Yes Yes
## 114        12   Yes Yes
## 115        13   Yes Yes
## 116        13   Yes  No
## 117        10    No  No
## 118        12   Yes  No
## 119        11   Yes Yes
## 120        12   Yes Yes
## 121        13   Yes Yes
## 122        10   Yes Yes
## 123        10   Yes Yes
## 124        15    No Yes
## 125        14   Yes  No
## 126        15    No  No
## 127        16   Yes Yes
## 128        14   Yes Yes
## 129        13   Yes Yes
## 130        10    No Yes
## 131        12   Yes Yes
## 132        16   Yes  No
## 133        10   Yes Yes
## 134        12   Yes Yes
```

```
## 135        16   Yes  No
## 136        18    No Yes
## 137        18    No  No
## 138        11   Yes  No
## 139        10   Yes Yes
## 140        13    No Yes
## 141        18   Yes Yes
## 142        15   Yes  No
## 143        15   Yes  No
## 144        17   Yes Yes
## 145        11    No  No
## 146        17   Yes Yes
## 147        14   Yes  No
## 148        16    No Yes
## 149        14    No Yes
## 150        11   Yes Yes
## 151        10    No Yes
## 152        17    No Yes
## 153        13    No  No
## 154        17    No Yes
## 155        16    No Yes
## 156        16   Yes  No
## 157        16   Yes  No
## 158        13    No Yes
## 159        10    No Yes
## 160        18    No  No
## 161        12    No  No
## 162        12    No Yes
## 163        13   Yes  No
## 164        17    No  No
## 165        13    No Yes
## 166        15   Yes Yes
## 167        11   Yes Yes
## 168        13   Yes  No
## 169        10   Yes  No
## 170        18   Yes Yes
## 171        10   Yes Yes
## 172        15   Yes Yes
## 173        16   Yes Yes
## 174        18   Yes Yes
## 175        15    No  No
## 176        12   Yes  No
## 177        11    No Yes
## 178        17   Yes Yes
## 179        14    No Yes
## 180        18   Yes Yes
## 181        13   Yes Yes
## 182        11   Yes  No
## 183        13   Yes  No
## 184        18   Yes Yes
## 185        11    No Yes
## 186        10   Yes Yes
## 187        17    No  No
## 188        17   Yes  No
```

```
## 189        15   Yes  No
## 190        15    No Yes
## 191        13    No Yes
## 192        14   Yes Yes
## 193        14    No  No
## 194        10   Yes Yes
## 195        11   Yes Yes
## 196        11   Yes Yes
## 197        16   Yes Yes
## 198        16   Yes  No
## 199        10   Yes Yes
## 200        14   Yes Yes
## 201        12    No  No
## 202        18   Yes  No
## 203        10    No Yes
## 204        14   Yes  No
## 205        14   Yes  No
## 206        12   Yes  No
## 207        17   Yes Yes
## 208        10    No  No
## 209        12   Yes  No
## 210        11    No Yes
## 211        14    No Yes
## 212        15   Yes Yes
## 213        11   Yes Yes
## 214        10   Yes Yes
## 215        18   Yes Yes
## 216        11   Yes Yes
## 217        17   Yes  No
## 218        14    No  No
## 219        14   Yes Yes
## 220        17   Yes Yes
## 221        10   Yes Yes
## 222        11   Yes  No
## 223        13   Yes Yes
## 224        14   Yes Yes
## 225        13    No  No
## 226        14   Yes  No
## 227        14   Yes  No
## 228        16   Yes Yes
## 229        11    No Yes
## 230        18    No  No
## 231        14    No  No
## 232        11    No  No
## 233        15   Yes Yes
## 234        14    No Yes
## 235        16    No Yes
## 236        17   Yes Yes
## 237        10   Yes Yes
## 238        10   Yes Yes
## 239        13   Yes  No
## 240        16   Yes Yes
## 241        18   Yes  No
## 242        12   Yes  No
```

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## 243        14    No  No
## 244        10   Yes Yes
## 245        18   Yes  No
## 246        10    No Yes
## 247        18   Yes Yes
## 248        16   Yes  No
## 249        11   Yes Yes
## 250        11   Yes  No
## 251        14   Yes Yes
## 252        13   Yes Yes
## 253        16   Yes  No
## 254        12    No Yes
## 255        17   Yes Yes
## 256        15   Yes Yes
## 257        10   Yes  No
## 258        13   Yes Yes
## 259        14    No  No
## 260        11    No Yes
## 261        10   Yes Yes
## 262        15   Yes Yes
## 263        18   Yes Yes
## 264        17   Yes Yes
## 265        15   Yes Yes
## 266        17   Yes Yes
## 267        17    No Yes
## 268        12    No Yes
## 269        11   Yes  No
## 270        17   Yes  No
## 271        10   Yes  No
## 272        16   Yes  No
## 273        12   Yes  No
## 274        12   Yes Yes
## 275        11   Yes Yes
## 276        11   Yes Yes
## 277        15   Yes Yes
## 278        16   Yes Yes
## 279        15    No Yes
## 280        18   Yes Yes
## 281        10   Yes Yes
## 282        16    No Yes
## 283        11   Yes  No
## 284        16    No  No
## 285        17    No  No
## 286        10   Yes Yes
## 287        18    No Yes
## 288        17   Yes Yes
## 289        15    No  No
## 290        17   Yes Yes
## 291        11    No Yes
## 292        17   Yes  No
## 293        15   Yes Yes
## 294        10   Yes  No
## 295        11   Yes Yes
## 296        10    No Yes
```

```
## 297        18   Yes Yes
## 298        10   Yes Yes
## 299        15   Yes  No
## 300        17    No Yes
## 301        11   Yes Yes
## 302        16   Yes Yes
## 303        14   Yes Yes
## 304        11   Yes Yes
## 305        10   Yes Yes
## 306        13   Yes Yes
## 307        12   Yes Yes
## 308        12   Yes  No
## 309        10   Yes Yes
## 310        18   Yes Yes
## 311        12   Yes Yes
## 312        14   Yes Yes
## 313        10   Yes Yes
## 314        13   Yes  No
## 315        14   Yes Yes
## 316        14   Yes Yes
## 317        10   Yes Yes
## 318        15    No  No
## 319        14    No Yes
## 320        11    No Yes
## 321        18   Yes Yes
## 322        15   Yes  No
## 323        15   Yes Yes
## 324        12   Yes Yes
## 325        13   Yes Yes
## 326        11   Yes Yes
## 327        17   Yes  No
## 328        16   Yes Yes
## 329        11   Yes Yes
## 330        12   Yes Yes
## 331        14    No  No
## 332        10   Yes Yes
## 333        12   Yes Yes
## 334        10   Yes Yes
## 335        13   Yes Yes
## 336        15   Yes Yes
## 337        18   Yes  No
## 338        15   Yes  No
## 339        11   Yes  No
## 340        15   Yes Yes
## 341        16   Yes  No
## 342        10    No  No
## 343        10    No Yes
## 344        14   Yes Yes
## 345        13    No Yes
## 346        12   Yes  No
## 347        13    No  No
## 348        14    No  No
## 349        11   Yes Yes
## 350        14    No Yes
```

```
## 351        17    No Yes
## 352        16    No Yes
## 353        17   Yes Yes
## 354        12    No Yes
## 355        18   Yes Yes
## 356        11   Yes  No
## 357        12   Yes  No
## 358        15   Yes Yes
## 359        11   Yes Yes
## 360        14   Yes Yes
## 361        15    No Yes
## 362        15    No Yes
## 363        12   Yes Yes
## 364        12   Yes  No
## 365        14   Yes Yes
## 366        17    No  No
## 367        12    No Yes
## 368        17   Yes  No
## 369        14    No Yes
## 370        14   Yes Yes
## 371        12   Yes Yes
## 372        16   Yes  No
## 373        11    No  No
## 374        17   Yes  No
## 375        12   Yes Yes
## 376        11   Yes  No
## 377        11   Yes Yes
## 378        12    No  No
## 379        12   Yes Yes
## 380        15   Yes  No
## 381        17   Yes Yes
## 382        13   Yes Yes
## 383        14   Yes Yes
## 384        10   Yes  No
## 385        12   Yes Yes
## 386        17   Yes Yes
## 387        16   Yes  No
## 388        14    No Yes
## 389        16   Yes Yes
## 390        12   Yes Yes
## 391        12   Yes Yes
## 392        16   Yes  No
## 393        13   Yes Yes
## 394        17    No Yes
## 395        16   Yes Yes
## 396        14   Yes Yes
## 397        11    No Yes
## 398        18   Yes Yes
## 399        12   Yes Yes
## 400        16   Yes Yes
```

```
str(Carseats)
```

```
## 'data.frame':    400 obs. of  12 variables:
```

```
##  $ X           : int  0 1 2 3 4 5 6 7 8 9 ...
##  $ Sales       : num  9.5 11.22 10.06 7.4 4.15 ...
##  $ CompPrice   : int  138 111 113 117 141 124 115 136 132 132 ...
##  $ Income      : int  73 48 35 100 64 113 105 81 110 113 ...
##  $ Advertising: int  11 16 10 4 3 13 0 15 0 0 ...
##  $ Population : int  276 260 269 466 340 501 45 425 108 131 ...
##  $ Price       : int  120 83 80 97 128 72 108 120 124 124 ...
##  $ ShelveLoc   : chr  "Bad" "Good" "Medium" "Medium" ...
##  $ Age         : int  42 65 59 55 38 78 71 67 76 76 ...
##  $ Education   : int  17 10 12 14 13 16 15 10 10 17 ...
##  $ Urban       : chr  "Yes" "Yes" "Yes" "Yes" ...
##  $ US          : chr  "Yes" "Yes" "Yes" "Yes" ...
```

```
head(Carseats)
```

```
##   X Sales CompPrice Income Advertising Population Price ShelveLoc Age Education
## 1 0  9.50       138     73          11        276   120       Bad  42        17
## 2 1 11.22       111     48          16        260    83      Good  65        10
## 3 2 10.06       113     35          10        269    80    Medium  59        12
## 4 3  7.40       117    100           4        466    97    Medium  55        14
## 5 4  4.15       141     64           3        340   128       Bad  38        13
## 6 5 10.81       124    113          13        501    72       Bad  78        16
##   Urban  US
## 1   Yes Yes
## 2   Yes Yes
## 3   Yes Yes
## 4   Yes Yes
## 5   Yes  No
## 6    No Yes
```

```
Carseats_Filtered <- Carseats %>% select("Sales", "Price", "Advertising","Population","Age","Income","E

#Question 1

set.seed(123)
trainIndex <- createDataPartition(Carseats$Sales, p = 0.8, list = FALSE)
trainData <- Carseats[trainIndex, ]
testData <- Carseats[-trainIndex, ]

# Extract predictor variables
predictors <- c("Price", "Advertising", "Population", "Age", "Income", "Education")
trainX <- trainData[, predictors]
testX <- testData[, predictors]

# Scale the predictor variables
preproc <- preProcess(trainX, method = c("center", "scale"))
trainX <- predict(preproc, as.matrix(trainX))
testX <- predict(preproc, as.matrix(testX))


# Use cross-validation to determine the optimal value of lambda
cvModel <- cv.glmnet(x = as.matrix(trainX), y = trainData$Sales, alpha = 1, nfolds = 5)
lambda <- cvModel$lambda.min
```

```r
# Train the Lasso regression model on the training set using the optimal value of lambda
lassoModel <- glmnet(x = as.matrix(trainX), y = trainData$Sales, alpha = 1, lambda = lambda)

# Print the optimal value of lambda
print(paste("The optimal value of lambda is", lambda))
```

```
## [1] "The optimal value of lambda is 0.00451294034403994"
```

```r
# Predict on the testing set
testPredictions <- predict(lassoModel, newx = as.matrix(testX), s = lambda)

# Calculate the mean squared error
mse <- mean((testData$Sales - testPredictions)^2)
print(paste("The mean squared error on the testing set is", round(mse, 2)))
```

```
## [1] "The mean squared error on the testing set is 5.33"
```

```r
# Question 2
lassoCoef <- coef(lassoModel, s = lambda)
lassoCoef["Price",]
```

```
## [1] -1.299902
```

```r
#question 3
lassoModel01 <- glmnet(x = trainX, y = trainData$Sales, alpha = 1, lambda = 0.01)
nonZeroCoeffs01 <- sum(coef(lassoModel01) != 0)

# Determine the number of non-zero coefficients for lambda = 0.1
lassoModel1 <- glmnet(x = trainX, y = trainData$Sales, alpha = 1, lambda = 0.1)
nonZeroCoeffs1 <- sum(coef(lassoModel1) != 0)

# Print the number of non-zero coefficients for lambda = 0.01 and lambda = 0.1
print(paste("Number of non-zero coefficients for lambda = 0.01:", nonZeroCoeffs01))
```

```
## [1] "Number of non-zero coefficients for lambda = 0.01: 7"
```

```r
print(paste("Number of non-zero coefficients for lambda = 0.1:", nonZeroCoeffs1))
```

```
## [1] "Number of non-zero coefficients for lambda = 0.1: 6"
```

```r
#question 4
# Build the Elastic-Net model with alpha=0.6
enetModel <- glmnet(x=trainX, y=trainData$Sales, alpha=0.6)

# Find the optimal value of lambda using cross-validation
cvModel <- cv.glmnet(x=trainX, y=trainData$Sales, alpha=0.6, nfolds=5)
lambda <- cvModel$lambda.min

# Print the optimal value of lambda
print(paste("The optimal value of lambda for the Elastic-Net model with alpha=0.6 is", lambda))
```

```
## [1] "The optimal value of lambda for the Elastic-Net model with alpha=0.6 is 0.00624453726258919"
```