RWorksheet_Sabarillo#4c.Rmd.

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2024-11-04

1.a

```
mpg_data <- read.csv("/cloud/project/worksheet#4/mpg.csv")
mpg_data
```

```
##      X manufacturer              model displ year cyl      trans drv cty
## 1    1         audi                 a4   1.8 1999   4   auto(l5)   f  18
## 2    2         audi                 a4   1.8 1999   4 manual(m5)   f  21
## 3    3         audi                 a4   2.0 2008   4 manual(m6)   f  20
## 4    4         audi                 a4   2.0 2008   4   auto(av)   f  21
## 5    5         audi                 a4   2.8 1999   6   auto(l5)   f  16
## 6    6         audi                 a4   2.8 1999   6 manual(m5)   f  18
## 7    7         audi                 a4   3.1 2008   6   auto(av)   f  18
## 8    8         audi          a4 quattro   1.8 1999   4 manual(m5)   4  18
## 9    9         audi          a4 quattro   1.8 1999   4   auto(l5)   4  16
## 10  10         audi          a4 quattro   2.0 2008   4 manual(m6)   4  20
## 11  11         audi          a4 quattro   2.0 2008   4   auto(s6)   4  19
## 12  12         audi          a4 quattro   2.8 1999   6   auto(l5)   4  15
## 13  13         audi          a4 quattro   2.8 1999   6 manual(m5)   4  17
## 14  14         audi          a4 quattro   3.1 2008   6   auto(s6)   4  17
## 15  15         audi          a4 quattro   3.1 2008   6 manual(m6)   4  15
## 16  16         audi          a6 quattro   2.8 1999   6   auto(l5)   4  15
## 17  17         audi          a6 quattro   3.1 2008   6   auto(s6)   4  17
## 18  18         audi          a6 quattro   4.2 2008   8   auto(s6)   4  16
## 19  19    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(14)   r  14
## 20  20    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(14)   r  11
## 21  21    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(14)   r  14
## 22  22    chevrolet c1500 suburban 2wd   5.7 1999   8   auto(14)   r  13
## 23  23    chevrolet c1500 suburban 2wd   6.0 2008   8   auto(14)   r  12
## 24  24    chevrolet           corvette   5.7 1999   8 manual(m6)   r  16
## 25  25    chevrolet           corvette   5.7 1999   8   auto(14)   r  15
## 26  26    chevrolet           corvette   6.2 2008   8 manual(m6)   r  16
## 27  27    chevrolet           corvette   6.2 2008   8   auto(s6)   r  15
## 28  28    chevrolet           corvette   7.0 2008   8 manual(m6)   r  15
## 29  29    chevrolet     k1500 tahoe 4wd   5.3 2008   8   auto(14)   4  14
## 30  30    chevrolet     k1500 tahoe 4wd   5.3 2008   8   auto(14)   4  11
## 31  31    chevrolet     k1500 tahoe 4wd   5.7 1999   8   auto(14)   4  11
## 32  32    chevrolet     k1500 tahoe 4wd   6.5 1999   8   auto(14)   4  14
## 33  33    chevrolet             malibu   2.4 1999   4   auto(14)   f  19
## 34  34    chevrolet             malibu   2.4 2008   4   auto(14)   f  22
## 35  35    chevrolet             malibu   3.1 1999   6   auto(14)   f  18
## 36  36    chevrolet             malibu   3.5 2008   6   auto(14)   f  18
## 37  37    chevrolet             malibu   3.6 2008   6   auto(s6)   f  17
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## 38  38    dodge          caravan 2wd  2.4 1999  4   auto(l3)  f  18
## 39  39    dodge          caravan 2wd  3.0 1999  6   auto(14)  f  17
## 40  40    dodge          caravan 2wd  3.3 1999  6   auto(14)  f  16
## 41  41    dodge          caravan 2wd  3.3 1999  6   auto(14)  f  16
## 42  42    dodge          caravan 2wd  3.3 2008  6   auto(14)  f  17
## 43  43    dodge          caravan 2wd  3.3 2008  6   auto(14)  f  17
## 44  44    dodge          caravan 2wd  3.3 2008  6   auto(14)  f  11
## 45  45    dodge          caravan 2wd  3.8 1999  6   auto(14)  f  15
## 46  46    dodge          caravan 2wd  3.8 1999  6   auto(14)  f  15
## 47  47    dodge          caravan 2wd  3.8 2008  6   auto(16)  f  16
## 48  48    dodge          caravan 2wd  4.0 2008  6   auto(16)  f  16
## 49  49    dodge    dakota pickup 4wd  3.7 2008  6 manual(m6)  4  15
## 50  50    dodge    dakota pickup 4wd  3.7 2008  6   auto(14)  4  14
## 51  51    dodge    dakota pickup 4wd  3.9 1999  6   auto(14)  4  13
## 52  52    dodge    dakota pickup 4wd  3.9 1999  6 manual(m5)  4  14
## 53  53    dodge    dakota pickup 4wd  4.7 2008  8   auto(15)  4  14
## 54  54    dodge    dakota pickup 4wd  4.7 2008  8   auto(15)  4  14
## 55  55    dodge    dakota pickup 4wd  4.7 2008  8   auto(15)  4   9
## 56  56    dodge    dakota pickup 4wd  5.2 1999  8 manual(m5)  4  11
## 57  57    dodge    dakota pickup 4wd  5.2 1999  8   auto(14)  4  11
## 58  58    dodge          durango 4wd  3.9 1999  6   auto(14)  4  13
## 59  59    dodge          durango 4wd  4.7 2008  8   auto(15)  4  13
## 60  60    dodge          durango 4wd  4.7 2008  8   auto(15)  4   9
## 61  61    dodge          durango 4wd  4.7 2008  8   auto(15)  4  13
## 62  62    dodge          durango 4wd  5.2 1999  8   auto(14)  4  11
## 63  63    dodge          durango 4wd  5.7 2008  8   auto(15)  4  13
## 64  64    dodge          durango 4wd  5.9 1999  8   auto(14)  4  11
## 65  65    dodge  ram 1500 pickup 4wd  4.7 2008  8 manual(m6)  4  12
## 66  66    dodge  ram 1500 pickup 4wd  4.7 2008  8   auto(15)  4   9
## 67  67    dodge  ram 1500 pickup 4wd  4.7 2008  8   auto(15)  4  13
## 68  68    dodge  ram 1500 pickup 4wd  4.7 2008  8   auto(15)  4  13
## 69  69    dodge  ram 1500 pickup 4wd  4.7 2008  8 manual(m6)  4  12
## 70  70    dodge  ram 1500 pickup 4wd  4.7 2008  8 manual(m6)  4   9
## 71  71    dodge  ram 1500 pickup 4wd  5.2 1999  8   auto(14)  4  11
## 72  72    dodge  ram 1500 pickup 4wd  5.2 1999  8 manual(m5)  4  11
## 73  73    dodge  ram 1500 pickup 4wd  5.7 2008  8   auto(15)  4  13
## 74  74    dodge  ram 1500 pickup 4wd  5.9 1999  8   auto(14)  4  11
## 75  75     ford       expedition 2wd  4.6 1999  8   auto(14)  r  11
## 76  76     ford       expedition 2wd  5.4 1999  8   auto(14)  r  11
## 77  77     ford       expedition 2wd  5.4 2008  8   auto(16)  r  12
## 78  78     ford         explorer 4wd  4.0 1999  6   auto(15)  4  14
## 79  79     ford         explorer 4wd  4.0 1999  6 manual(m5)  4  15
## 80  80     ford         explorer 4wd  4.0 1999  6   auto(15)  4  14
## 81  81     ford         explorer 4wd  4.0 2008  6   auto(15)  4  13
## 82  82     ford         explorer 4wd  4.6 2008  8   auto(16)  4  13
## 83  83     ford         explorer 4wd  5.0 1999  8   auto(14)  4  13
## 84  84     ford      f150 pickup 4wd  4.2 1999  6   auto(14)  4  14
## 85  85     ford      f150 pickup 4wd  4.2 1999  6 manual(m5)  4  14
## 86  86     ford      f150 pickup 4wd  4.6 1999  8 manual(m5)  4  13
## 87  87     ford      f150 pickup 4wd  4.6 1999  8   auto(14)  4  13
## 88  88     ford      f150 pickup 4wd  4.6 2008  8   auto(14)  4  13
## 89  89     ford      f150 pickup 4wd  5.4 1999  8   auto(14)  4  11
## 90  90     ford      f150 pickup 4wd  5.4 2008  8   auto(14)  4  13
## 91  91     ford              mustang  3.8 1999  6 manual(m5)  r  18
```

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## 92   92        ford              mustang 3.8 1999 6   auto(14) r 18
## 93   93        ford              mustang 4.0 2008 6 manual(m5) r 17
## 94   94        ford              mustang 4.0 2008 6   auto(15) r 16
## 95   95        ford              mustang 4.6 1999 8   auto(14) r 15
## 96   96        ford              mustang 4.6 1999 8 manual(m5) r 15
## 97   97        ford              mustang 4.6 2008 8 manual(m5) r 15
## 98   98        ford              mustang 4.6 2008 8   auto(15) r 15
## 99   99        ford              mustang 5.4 2008 8 manual(m6) r 14
## 100 100       honda                civic 1.6 1999 4 manual(m5) f 28
## 101 101       honda                civic 1.6 1999 4   auto(14) f 24
## 102 102       honda                civic 1.6 1999 4 manual(m5) f 25
## 103 103       honda                civic 1.6 1999 4 manual(m5) f 23
## 104 104       honda                civic 1.6 1999 4   auto(14) f 24
## 105 105       honda                civic 1.8 2008 4 manual(m5) f 26
## 106 106       honda                civic 1.8 2008 4   auto(15) f 25
## 107 107       honda                civic 1.8 2008 4   auto(15) f 24
## 108 108       honda                civic 2.0 2008 4 manual(m6) f 21
## 109 109     hyundai               sonata 2.4 1999 4   auto(14) f 18
## 110 110     hyundai               sonata 2.4 1999 4 manual(m5) f 18
## 111 111     hyundai               sonata 2.4 2008 4   auto(14) f 21
## 112 112     hyundai               sonata 2.4 2008 4 manual(m5) f 21
## 113 113     hyundai               sonata 2.5 1999 6   auto(14) f 18
## 114 114     hyundai               sonata 2.5 1999 6 manual(m5) f 18
## 115 115     hyundai               sonata 3.3 2008 6   auto(15) f 19
## 116 116     hyundai              tiburon 2.0 1999 4   auto(14) f 19
## 117 117     hyundai              tiburon 2.0 1999 4 manual(m5) f 19
## 118 118     hyundai              tiburon 2.0 2008 4 manual(m5) f 20
## 119 119     hyundai              tiburon 2.0 2008 4   auto(14) f 20
## 120 120     hyundai              tiburon 2.7 2008 6   auto(14) f 17
## 121 121     hyundai              tiburon 2.7 2008 6 manual(m6) f 16
## 122 122     hyundai              tiburon 2.7 2008 6 manual(m5) f 17
## 123 123        jeep     grand cherokee 4wd 3.0 2008 6   auto(15) 4 17
## 124 124        jeep     grand cherokee 4wd 3.7 2008 6   auto(15) 4 15
## 125 125        jeep     grand cherokee 4wd 4.0 1999 6   auto(14) 4 15
## 126 126        jeep     grand cherokee 4wd 4.7 1999 8   auto(14) 4 14
## 127 127        jeep     grand cherokee 4wd 4.7 2008 8   auto(15) 4  9
## 128 128        jeep     grand cherokee 4wd 4.7 2008 8   auto(15) 4 14
## 129 129        jeep     grand cherokee 4wd 5.7 2008 8   auto(15) 4 13
## 130 130        jeep     grand cherokee 4wd 6.1 2008 8   auto(15) 4 11
## 131 131  land rover           range rover 4.0 1999 8   auto(14) 4 11
## 132 132  land rover           range rover 4.2 2008 8   auto(s6) 4 12
## 133 133  land rover           range rover 4.4 2008 8   auto(s6) 4 12
## 134 134  land rover           range rover 4.6 1999 8   auto(14) 4 11
## 135 135     lincoln         navigator 2wd 5.4 1999 8   auto(14) r 11
## 136 136     lincoln         navigator 2wd 5.4 1999 8   auto(14) r 11
## 137 137     lincoln         navigator 2wd 5.4 2008 8   auto(16) r 12
## 138 138     mercury       mountaineer 4wd 4.0 1999 6   auto(15) 4 14
## 139 139     mercury       mountaineer 4wd 4.0 2008 6   auto(15) 4 13
## 140 140     mercury       mountaineer 4wd 4.6 2008 8   auto(16) 4 13
## 141 141     mercury       mountaineer 4wd 5.0 1999 8   auto(14) 4 13
## 142 142      nissan               altima 2.4 1999 4 manual(m5) f 21
## 143 143      nissan               altima 2.4 1999 4   auto(14) f 19
## 144 144      nissan               altima 2.5 2008 4   auto(av) f 23
## 145 145      nissan               altima 2.5 2008 4 manual(m6) f 23
```

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## 146 146       nissan                  altima 3.5 2008  6 manual(m6)  f  19
## 147 147       nissan                  altima 3.5 2008  6   auto(av)  f  19
## 148 148       nissan                  maxima 3.0 1999  6   auto(14)  f  18
## 149 149       nissan                  maxima 3.0 1999  6 manual(m5)  f  19
## 150 150       nissan                  maxima 3.5 2008  6   auto(av)  f  19
## 151 151       nissan           pathfinder 4wd 3.3 1999  6   auto(14)  4  14
## 152 152       nissan           pathfinder 4wd 3.3 1999  6 manual(m5)  4  15
## 153 153       nissan           pathfinder 4wd 4.0 2008  6   auto(15)  4  14
## 154 154       nissan           pathfinder 4wd 5.6 2008  8   auto(s5)  4  12
## 155 155      pontiac              grand prix 3.1 1999  6   auto(14)  f  18
## 156 156      pontiac              grand prix 3.8 1999  6   auto(14)  f  16
## 157 157      pontiac              grand prix 3.8 1999  6   auto(14)  f  17
## 158 158      pontiac              grand prix 3.8 2008  6   auto(14)  f  18
## 159 159      pontiac              grand prix 5.3 2008  8   auto(s4)  f  16
## 160 160       subaru            forester awd 2.5 1999  4 manual(m5)  4  18
## 161 161       subaru            forester awd 2.5 1999  4   auto(14)  4  18
## 162 162       subaru            forester awd 2.5 2008  4 manual(m5)  4  20
## 163 163       subaru            forester awd 2.5 2008  4 manual(m5)  4  19
## 164 164       subaru            forester awd 2.5 2008  4   auto(14)  4  20
## 165 165       subaru            forester awd 2.5 2008  4   auto(14)  4  18
## 166 166       subaru             impreza awd 2.2 1999  4   auto(14)  4  21
## 167 167       subaru             impreza awd 2.2 1999  4 manual(m5)  4  19
## 168 168       subaru             impreza awd 2.5 1999  4 manual(m5)  4  19
## 169 169       subaru             impreza awd 2.5 1999  4   auto(14)  4  19
## 170 170       subaru             impreza awd 2.5 2008  4   auto(s4)  4  20
## 171 171       subaru             impreza awd 2.5 2008  4   auto(s4)  4  20
## 172 172       subaru             impreza awd 2.5 2008  4 manual(m5)  4  19
## 173 173       subaru             impreza awd 2.5 2008  4 manual(m5)  4  20
## 174 174       toyota             4runner 4wd 2.7 1999  4 manual(m5)  4  15
## 175 175       toyota             4runner 4wd 2.7 1999  4   auto(14)  4  16
## 176 176       toyota             4runner 4wd 3.4 1999  6   auto(14)  4  15
## 177 177       toyota             4runner 4wd 3.4 1999  6 manual(m5)  4  15
## 178 178       toyota             4runner 4wd 4.0 2008  6   auto(15)  4  16
## 179 179       toyota             4runner 4wd 4.7 2008  8   auto(15)  4  14
## 180 180       toyota                   camry 2.2 1999  4 manual(m5)  f  21
## 181 181       toyota                   camry 2.2 1999  4   auto(14)  f  21
## 182 182       toyota                   camry 2.4 2008  4 manual(m5)  f  21
## 183 183       toyota                   camry 2.4 2008  4   auto(15)  f  21
## 184 184       toyota                   camry 3.0 1999  6   auto(14)  f  18
## 185 185       toyota                   camry 3.0 1999  6 manual(m5)  f  18
## 186 186       toyota                   camry 3.5 2008  6   auto(s6)  f  19
## 187 187       toyota            camry solara 2.2 1999  4   auto(14)  f  21
## 188 188       toyota            camry solara 2.2 1999  4 manual(m5)  f  21
## 189 189       toyota            camry solara 2.4 2008  4 manual(m5)  f  21
## 190 190       toyota            camry solara 2.4 2008  4   auto(s5)  f  22
## 191 191       toyota            camry solara 3.0 1999  6   auto(14)  f  18
## 192 192       toyota            camry solara 3.0 1999  6 manual(m5)  f  18
## 193 193       toyota            camry solara 3.3 2008  6   auto(s5)  f  18
## 194 194       toyota                 corolla 1.8 1999  4   auto(13)  f  24
## 195 195       toyota                 corolla 1.8 1999  4   auto(14)  f  24
## 196 196       toyota                 corolla 1.8 1999  4 manual(m5)  f  26
## 197 197       toyota                 corolla 1.8 2008  4 manual(m5)  f  28
## 198 198       toyota                 corolla 1.8 2008  4   auto(14)  f  26
## 199 199       toyota land cruiser wagon 4wd 4.7 1999  8   auto(14)  4  11
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## 200 200        toyota land cruiser wagon 4wd 5.7 2008  8  auto(s6)  4 13
## 201 201        toyota        toyota tacoma 4wd 2.7 1999  4 manual(m5) 4 15
## 202 202        toyota        toyota tacoma 4wd 2.7 1999  4  auto(14)  4 16
## 203 203        toyota        toyota tacoma 4wd 2.7 2008  4 manual(m5) 4 17
## 204 204        toyota        toyota tacoma 4wd 3.4 1999  6 manual(m5) 4 15
## 205 205        toyota        toyota tacoma 4wd 3.4 1999  6  auto(14)  4 15
## 206 206        toyota        toyota tacoma 4wd 4.0 2008  6 manual(m6) 4 15
## 207 207        toyota        toyota tacoma 4wd 4.0 2008  6  auto(15)  4 16
## 208 208    volkswagen                    gti 2.0 1999  4 manual(m5) f 21
## 209 209    volkswagen                    gti 2.0 1999  4  auto(14)  f 19
## 210 210    volkswagen                    gti 2.0 2008  4 manual(m6) f 21
## 211 211    volkswagen                    gti 2.0 2008  4  auto(s6)  f 22
## 212 212    volkswagen                    gti 2.8 1999  6 manual(m5) f 17
## 213 213    volkswagen                  jetta 1.9 1999  4 manual(m5) f 33
## 214 214    volkswagen                  jetta 2.0 1999  4 manual(m5) f 21
## 215 215    volkswagen                  jetta 2.0 1999  4  auto(14)  f 19
## 216 216    volkswagen                  jetta 2.0 2008  4  auto(s6)  f 22
## 217 217    volkswagen                  jetta 2.0 2008  4 manual(m6) f 21
## 218 218    volkswagen                  jetta 2.5 2008  5  auto(s6)  f 21
## 219 219    volkswagen                  jetta 2.5 2008  5 manual(m5) f 21
## 220 220    volkswagen                  jetta 2.8 1999  6  auto(14)  f 16
## 221 221    volkswagen                  jetta 2.8 1999  6 manual(m5) f 17
## 222 222    volkswagen             new beetle 1.9 1999  4 manual(m5) f 35
## 223 223    volkswagen             new beetle 1.9 1999  4  auto(14)  f 29
## 224 224    volkswagen             new beetle 2.0 1999  4 manual(m5) f 21
## 225 225    volkswagen             new beetle 2.0 1999  4  auto(14)  f 19
## 226 226    volkswagen             new beetle 2.5 2008  5 manual(m5) f 20
## 227 227    volkswagen             new beetle 2.5 2008  5  auto(s6)  f 20
## 228 228    volkswagen                 passat 1.8 1999  4 manual(m5) f 21
## 229 229    volkswagen                 passat 1.8 1999  4  auto(15)  f 18
## 230 230    volkswagen                 passat 2.0 2008  4  auto(s6)  f 19
## 231 231    volkswagen                 passat 2.0 2008  4 manual(m6) f 21
## 232 232    volkswagen                 passat 2.8 1999  6  auto(15)  f 16
## 233 233    volkswagen                 passat 2.8 1999  6 manual(m5) f 18
## 234 234    volkswagen                 passat 3.6 2008  6  auto(s6)  f 17
##     hwy fl    class
## 1    29  p  compact
## 2    29  p  compact
## 3    31  p  compact
## 4    30  p  compact
## 5    26  p  compact
## 6    26  p  compact
## 7    27  p  compact
## 8    26  p  compact
## 9    25  p  compact
## 10   28  p  compact
## 11   27  p  compact
## 12   25  p  compact
## 13   25  p  compact
## 14   25  p  compact
## 15   25  p  compact
## 16   24  p  midsize
## 17   25  p  midsize
## 18   23  p  midsize
```

```
## 19    20   r         suv
## 20    15   e         suv
## 21    20   r         suv
## 22    17   r         suv
## 23    17   r         suv
## 24    26   p      2seater
## 25    23   p      2seater
## 26    26   p      2seater
## 27    25   p      2seater
## 28    24   p      2seater
## 29    19   r         suv
## 30    14   e         suv
## 31    15   r         suv
## 32    17   d         suv
## 33    27   r      midsize
## 34    30   r      midsize
## 35    26   r      midsize
## 36    29   r      midsize
## 37    26   r      midsize
## 38    24   r      minivan
## 39    24   r      minivan
## 40    22   r      minivan
## 41    22   r      minivan
## 42    24   r      minivan
## 43    24   r      minivan
## 44    17   e      minivan
## 45    22   r      minivan
## 46    21   r      minivan
## 47    23   r      minivan
## 48    23   r      minivan
## 49    19   r       pickup
## 50    18   r       pickup
## 51    17   r       pickup
## 52    17   r       pickup
## 53    19   r       pickup
## 54    19   r       pickup
## 55    12   e       pickup
## 56    17   r       pickup
## 57    15   r       pickup
## 58    17   r         suv
## 59    17   r         suv
## 60    12   e         suv
## 61    17   r         suv
## 62    16   r         suv
## 63    18   r         suv
## 64    15   r         suv
## 65    16   r       pickup
## 66    12   e       pickup
## 67    17   r       pickup
## 68    17   r       pickup
## 69    16   r       pickup
## 70    12   e       pickup
## 71    15   r       pickup
## 72    16   r       pickup
```

```
## 73   17   r      pickup
## 74   15   r      pickup
## 75   17   r         suv
## 76   17   r         suv
## 77   18   r         suv
## 78   17   r         suv
## 79   19   r         suv
## 80   17   r         suv
## 81   19   r         suv
## 82   19   r         suv
## 83   17   r         suv
## 84   17   r      pickup
## 85   17   r      pickup
## 86   16   r      pickup
## 87   16   r      pickup
## 88   17   r      pickup
## 89   15   r      pickup
## 90   17   r      pickup
## 91   26   r subcompact
## 92   25   r subcompact
## 93   26   r subcompact
## 94   24   r subcompact
## 95   21   r subcompact
## 96   22   r subcompact
## 97   23   r subcompact
## 98   22   r subcompact
## 99   20   p subcompact
## 100  33   r subcompact
## 101  32   r subcompact
## 102  32   r subcompact
## 103  29   p subcompact
## 104  32   r subcompact
## 105  34   r subcompact
## 106  36   r subcompact
## 107  36   c subcompact
## 108  29   p subcompact
## 109  26   r     midsize
## 110  27   r     midsize
## 111  30   r     midsize
## 112  31   r     midsize
## 113  26   r     midsize
## 114  26   r     midsize
## 115  28   r     midsize
## 116  26   r subcompact
## 117  29   r subcompact
## 118  28   r subcompact
## 119  27   r subcompact
## 120  24   r subcompact
## 121  24   r subcompact
## 122  24   r subcompact
## 123  22   d         suv
## 124  19   r         suv
## 125  20   r         suv
## 126  17   r         suv
```

```
## 127  12  e          suv
## 128  19  r          suv
## 129  18  r          suv
## 130  14  p          suv
## 131  15  p          suv
## 132  18  r          suv
## 133  18  r          suv
## 134  15  p          suv
## 135  17  r          suv
## 136  16  p          suv
## 137  18  r          suv
## 138  17  r          suv
## 139  19  r          suv
## 140  19  r          suv
## 141  17  r          suv
## 142  29  r      compact
## 143  27  r      compact
## 144  31  r      midsize
## 145  32  r      midsize
## 146  27  p      midsize
## 147  26  p      midsize
## 148  26  r      midsize
## 149  25  r      midsize
## 150  25  p      midsize
## 151  17  r          suv
## 152  17  r          suv
## 153  20  p          suv
## 154  18  p          suv
## 155  26  r      midsize
## 156  26  p      midsize
## 157  27  r      midsize
## 158  28  r      midsize
## 159  25  p      midsize
## 160  25  r          suv
## 161  24  r          suv
## 162  27  r          suv
## 163  25  p          suv
## 164  26  r          suv
## 165  23  p          suv
## 166  26  r subcompact
## 167  26  r subcompact
## 168  26  r subcompact
## 169  26  r subcompact
## 170  25  p      compact
## 171  27  r      compact
## 172  25  p      compact
## 173  27  r      compact
## 174  20  r          suv
## 175  20  r          suv
## 176  19  r          suv
## 177  17  r          suv
## 178  20  r          suv
## 179  17  r          suv
## 180  29  r      midsize
```

```
## 181 27  r    midsize
## 182 31  r    midsize
## 183 31  r    midsize
## 184 26  r    midsize
## 185 26  r    midsize
## 186 28  r    midsize
## 187 27  r    compact
## 188 29  r    compact
## 189 31  r    compact
## 190 31  r    compact
## 191 26  r    compact
## 192 26  r    compact
## 193 27  r    compact
## 194 30  r    compact
## 195 33  r    compact
## 196 35  r    compact
## 197 37  r    compact
## 198 35  r    compact
## 199 15  r        suv
## 200 18  r        suv
## 201 20  r     pickup
## 202 20  r     pickup
## 203 22  r     pickup
## 204 17  r     pickup
## 205 19  r     pickup
## 206 18  r     pickup
## 207 20  r     pickup
## 208 29  r    compact
## 209 26  r    compact
## 210 29  p    compact
## 211 29  p    compact
## 212 24  r    compact
## 213 44  d    compact
## 214 29  r    compact
## 215 26  r    compact
## 216 29  p    compact
## 217 29  p    compact
## 218 29  r    compact
## 219 29  r    compact
## 220 23  r    compact
## 221 24  r    compact
## 222 44  d subcompact
## 223 41  d subcompact
## 224 29  r subcompact
## 225 26  r subcompact
## 226 28  r subcompact
## 227 29  r subcompact
## 228 29  p    midsize
## 229 29  p    midsize
## 230 28  p    midsize
## 231 29  p    midsize
## 232 26  p    midsize
## 233 26  p    midsize
## 234 26  p    midsize
```

1.b - Based on the information provided, these are the categorical variables: manufacturer: The name of the car manufacturer. model: The specific model of the car. drv: The type of drive train (f = front-wheel drive, r = rear-wheel drive, 4 = 4wd). class: The type of car (e.g., compact, SUV).

```
str(mpg_data)
```

```
## 'data.frame':    234 obs. of  12 variables:
##  $ X          : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ manufacturer: chr  "audi" "audi" "audi" "audi" ...
##  $ model      : chr  "a4" "a4" "a4" "a4" ...
##  $ displ      : num  1.8 1.8 2 2 2.8 2.8 3.1 1.8 1.8 2 ...
##  $ year       : int  1999 1999 2008 2008 1999 1999 2008 1999 1999 2008 ...
##  $ cyl        : int  4 4 4 4 6 6 6 4 4 4 ...
##  $ trans      : chr  "auto(l5)" "manual(m5)" "manual(m6)" "auto(av)" ...
##  $ drv        : chr  "f" "f" "f" "f" ...
##  $ cty        : int  18 21 20 21 16 18 18 18 16 20 ...
##  $ hwy        : int  29 29 31 30 26 26 27 26 25 28 ...
##  $ fl         : chr  "p" "p" "p" "p" ...
##  $ class      : chr  "compact" "compact" "compact" "compact" ...
```

```
cat_Var <- sapply(mpg_data, is.character)
cat_Var
```

```
##            X manufacturer        model        displ         year          cyl
##        FALSE         TRUE         TRUE        FALSE        FALSE        FALSE
##        trans          drv          cty          hwy           fl        class
##         TRUE         TRUE        FALSE        FALSE         TRUE         TRUE
```

1.c - These are the continuous variables in the dataset: displ: Engine displacement (in liters). year: Year of manufacture. cyl: Number of cylinders. cty: City miles per gallon. hwy: Highway miles per gallon.

```
con_Var <- sapply(mpg_data, is.numeric)
con_Var
```

```
##            X manufacturer        model        displ         year          cyl
##         TRUE        FALSE        FALSE         TRUE         TRUE         TRUE
##        trans          drv          cty          hwy           fl        class
##        FALSE        FALSE         TRUE         TRUE        FALSE        FALSE
```

```
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(ggplot2)
```

2.a - model on the x-axis manufacturer on the y-axis Since both are categorical variables, the plot will show a grid of points. Each point represents a combination of a specific car model and its manufacturer.

```
model_counts <- mpg_data %>%
  group_by(manufacturer) %>%
  summarise(unique_models = n_distinct(model)) %>%
```

```
  arrange(desc(unique_models))

print(model_counts)

## # A tibble: 15 x 2
##    manufacturer unique_models
##    <chr>                <int>
##  1 toyota                   6
##  2 chevrolet                4
##  3 dodge                    4
##  4 ford                     4
##  5 volkswagen               4
##  6 audi                     3
##  7 nissan                   3
##  8 hyundai                  2
##  9 subaru                   2
## 10 honda                    1
## 11 jeep                     1
## 12 land rover               1
## 13 lincoln                  1
## 14 mercury                  1
## 15 pontiac                  1
```

```
top_manufacturer <- model_counts$manufacturer[1]
print(paste("The manufacturer with the most models is:", top_manufacturer))
```

```
## [1] "The manufacturer with the most models is: toyota"
```

2.b This plot might not be very useful in its basic form. Here's why and how to improve it: Overplotting:
Many car models might share the same manufacturer, leading to points overlapping and obscuring the actual
count. Lack of quantitative information: The plot doesn't tell us how many cars of each model a manufacturer
produces.Here are some ways to make it more informative: geom_jitter(): Instead of geom_point(), use
geom_jitter() to add some random noise to the point positions, reducing overplotting. geom_count(): This
geom will vary the size of the points based on how many times that model-manufacturer combination occurs.
Summarize and plot counts: Create a new data frame that counts the occurrences of each model-manufacturer
pair and then use geom_col() or geom_bar() to visualize the counts.

```
model_counts$manufacturer <- as.factor(model_counts$manufacturer)

plot(model_counts$manufacturer, model_counts$unique_models,
     type = "h",
     xlab = "Manufacturer",
     ylab = "Number of Unique Models",
     main = "Unique Models per Manufacturer")
```

Unique Models per Manufacturer
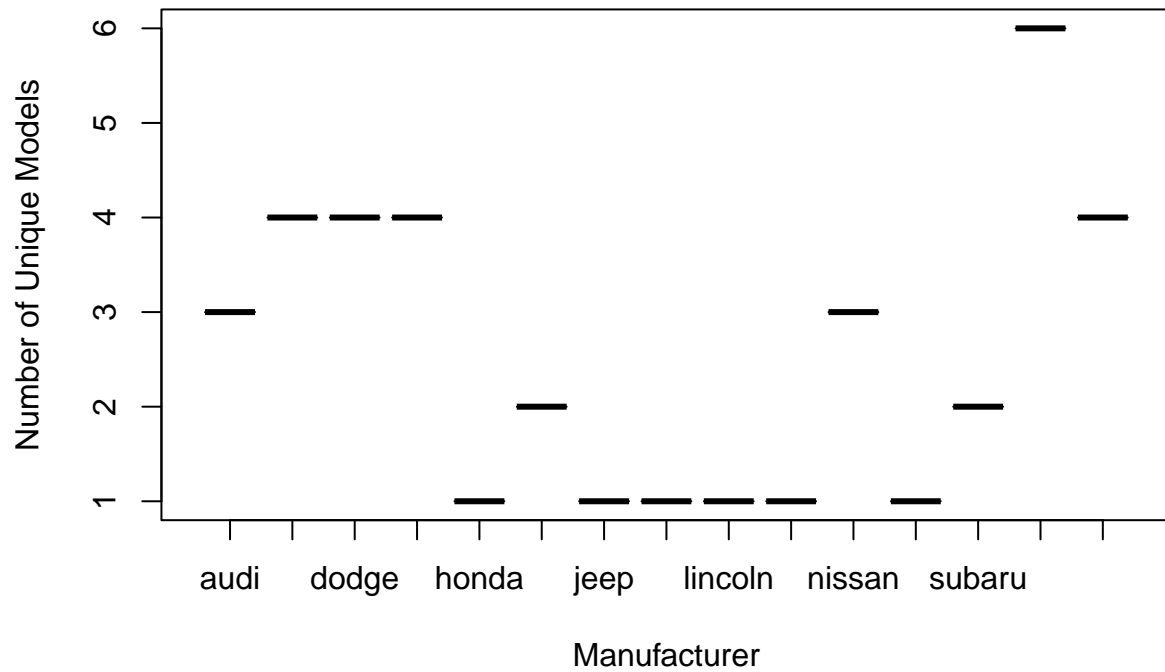

```
ggplot(model_counts, aes(x = manufacturer, y = unique_models)) +
  geom_col() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(x = "Manufacturer", y = "Number of Unique Models",
       title = "Unique Models per Manufacturer")
```
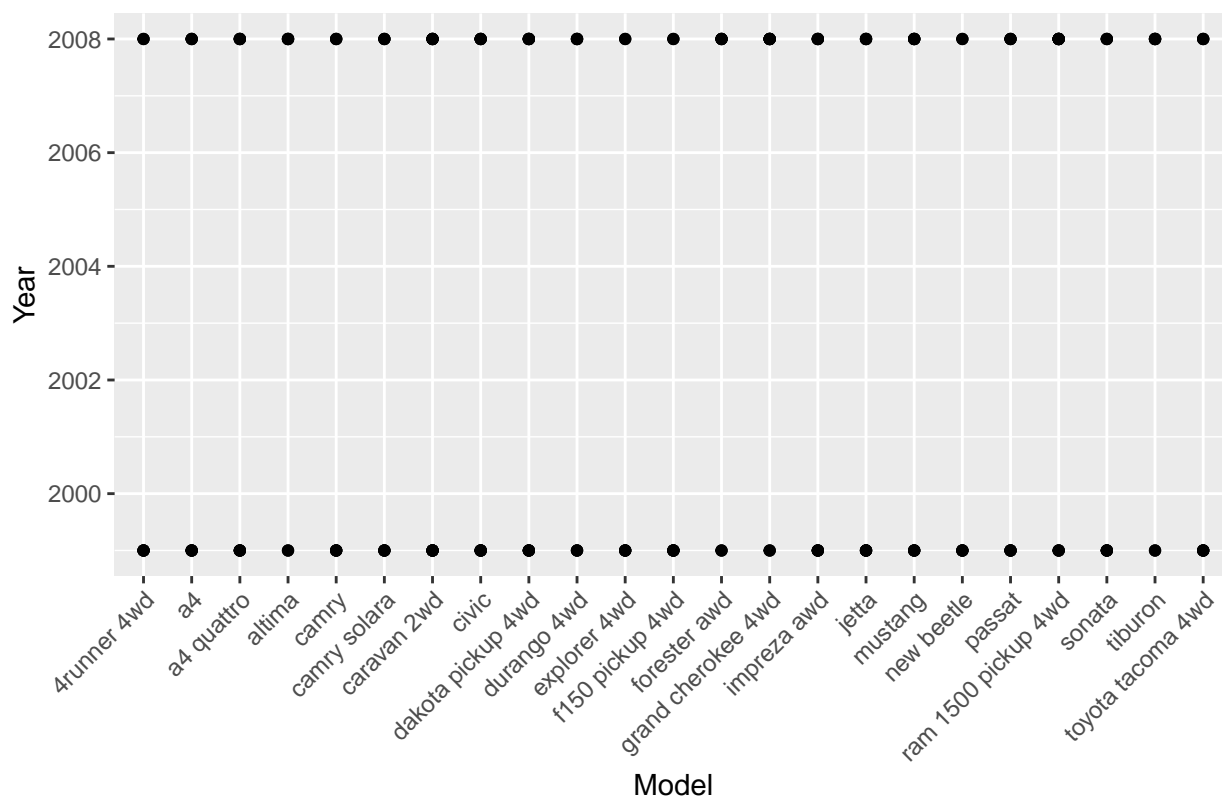
Unique Models per Manufacturer

3.
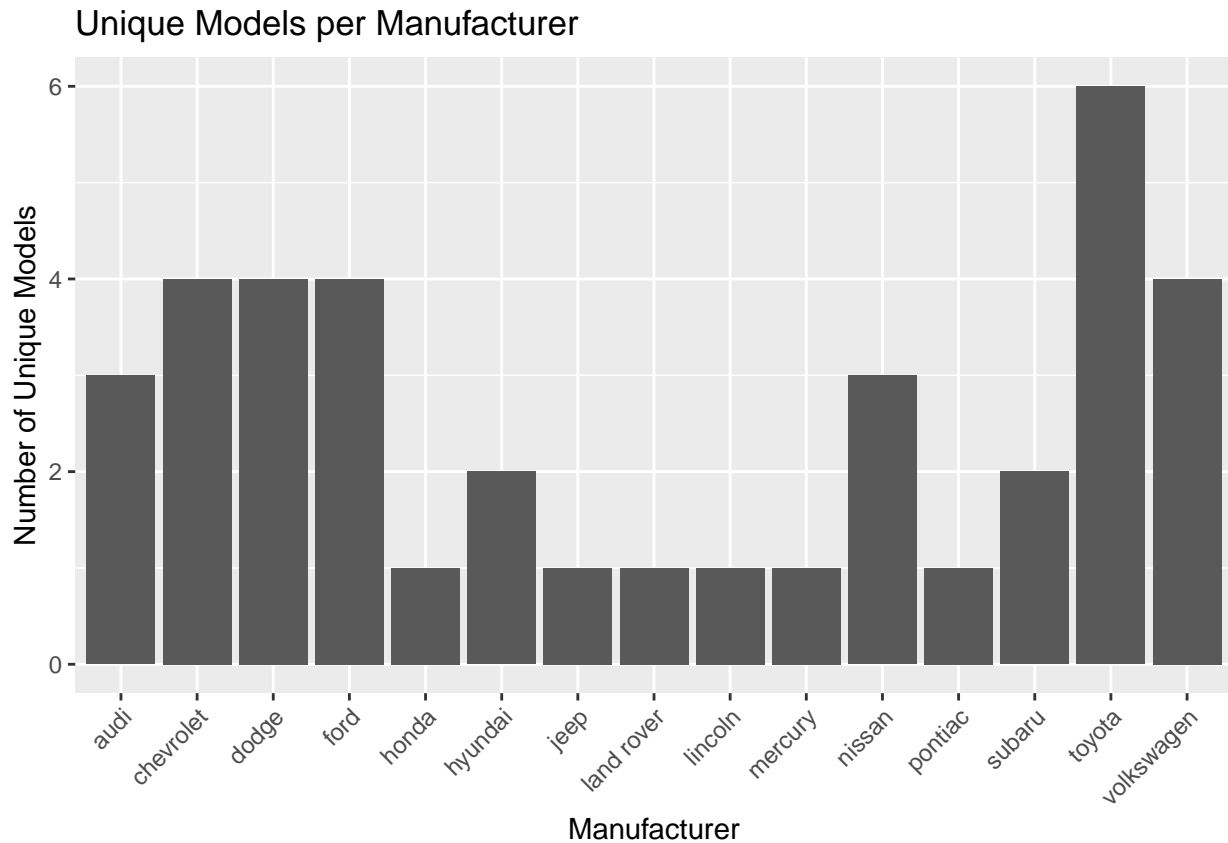
```r
top_models <- mpg_data %>%
  count(model) %>%
  top_n(20) %>%
  pull(model)
```

```
## Selecting by n
```

```r
top_model_data <- mpg_data %>%
  filter(model %in% top_models)

ggplot(top_model_data, aes(x = model, y = year)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(x = "Model", y = "Year", title = "Top 20 Models and Their Years")
```

Top 20 Models and Their Years

4.

```r
model_counts <- mpg_data %>%
  group_by(model) %>%
  summarise(count = n()) %>%
  arrange(desc(count))

print(model_counts)
```

```
## # A tibble: 38 x 2
##    model               count
##    <chr>               <int>
##  1 caravan 2wd            11
##  2 ram 1500 pickup 4wd    10
##  3 civic                   9
##  4 dakota pickup 4wd       9
##  5 jetta                   9
##  6 mustang                 9
##  7 a4 quattro              8
##  8 grand cherokee 4wd      8
##  9 impreza awd             8
## 10 a4                      7
## # i 28 more rows
```

4.a

```r
ggplot(model_counts[1:20, ], aes(x = model, y = count, fill = model)) +
  geom_col() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        legend.position = "none") +
```

```
labs(x = "Model", y = "Count", title = "Top 20 Car Models by Count") +
scale_fill_viridis_d()
```

Top 20 Car Models by Count
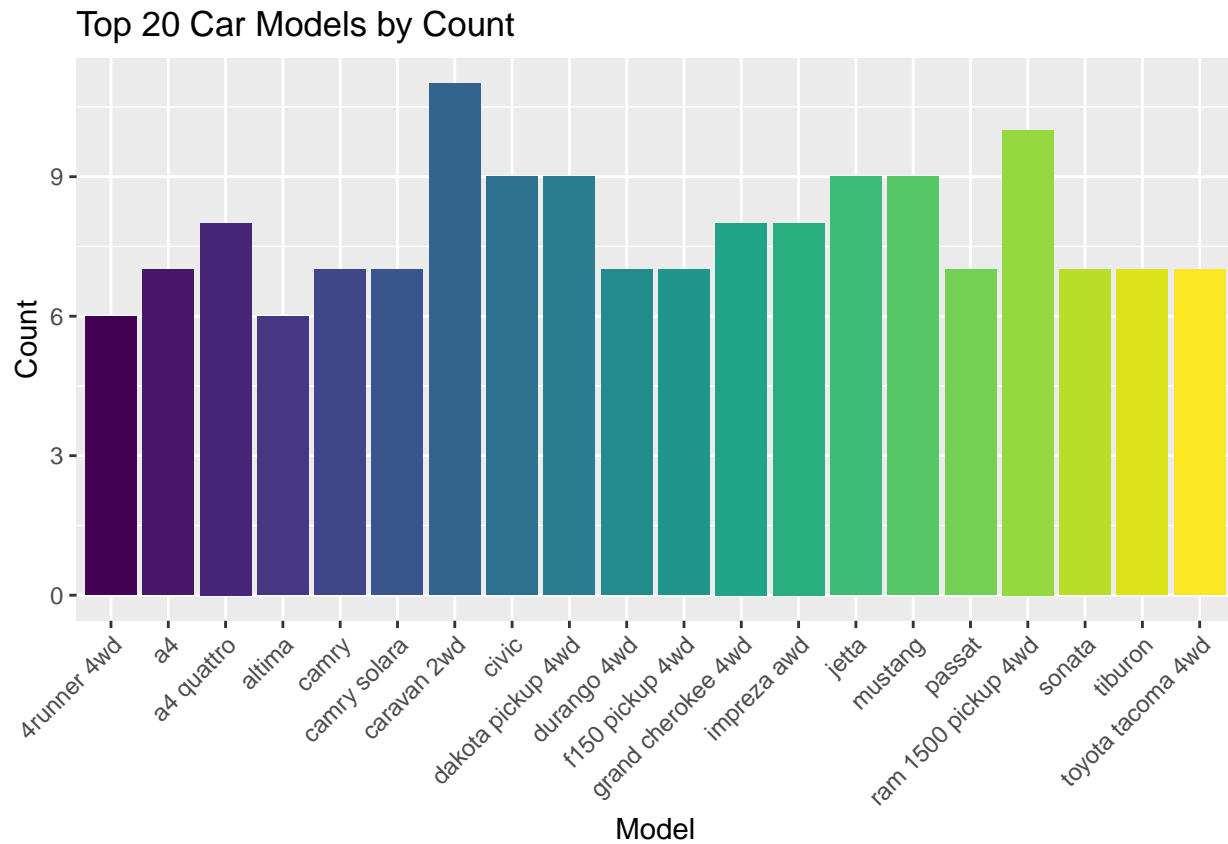
4.b

```
ggplot(model_counts[1:20, ], aes(x = model, y = count, fill = model)) +
  geom_col() +
  coord_flip() +
  theme(legend.position = "none") +
  labs(x = "Model", y = "Count", title = "Top 20 Car Models by Count") +
  scale_fill_viridis_d()
```

Top 20 Car Models by Count

5.a
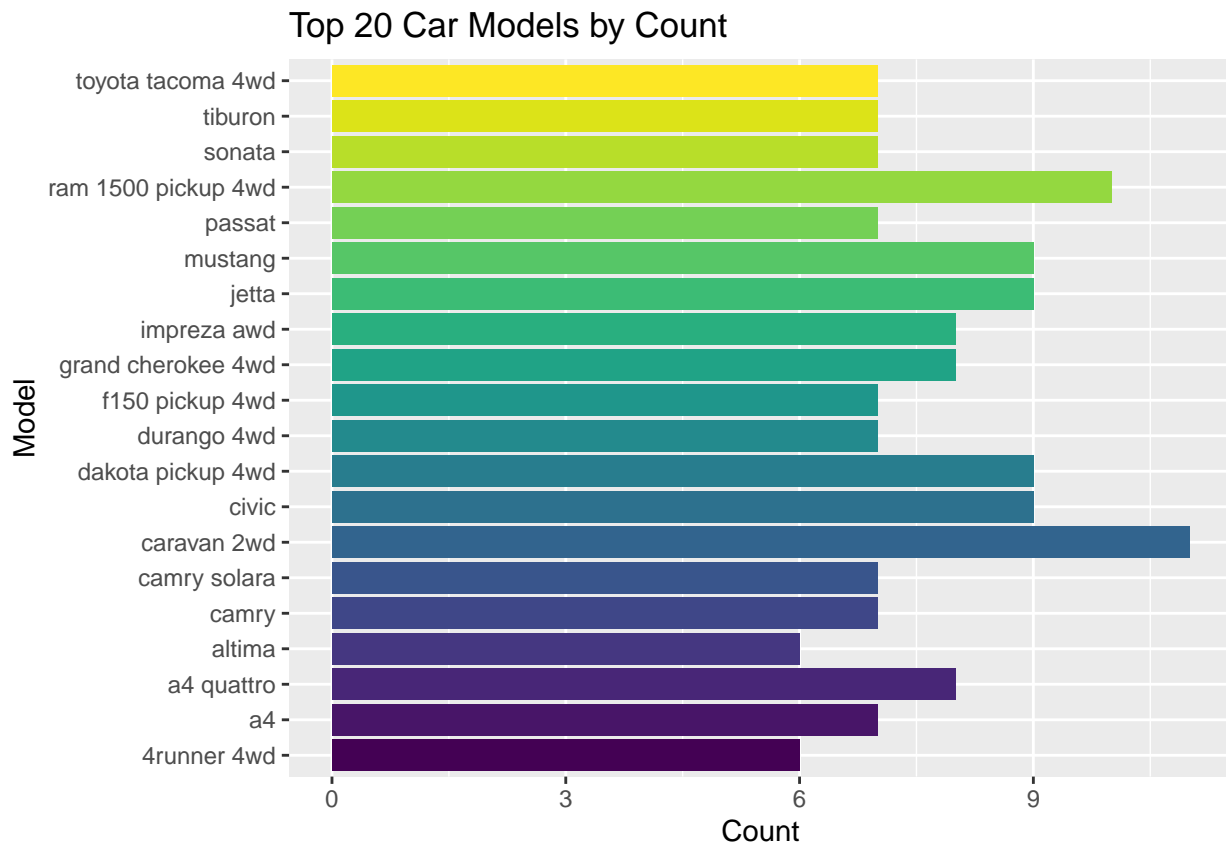
```r
ggplot(mpg_data, aes(x = cyl, y = displ, color = displ)) +
  geom_point() +
  labs(title = "Relationship between No. of Cylinders and Engine Displacement",
       x = "Number of Cylinders (cyl)",
       y = "Engine Displacement (displ)",
       color = "Engine Displacement") +
  scale_color_gradient(low = "blue", high = "red")
```

Relationship between No. of Cylinders and Engine Displacement

6.a
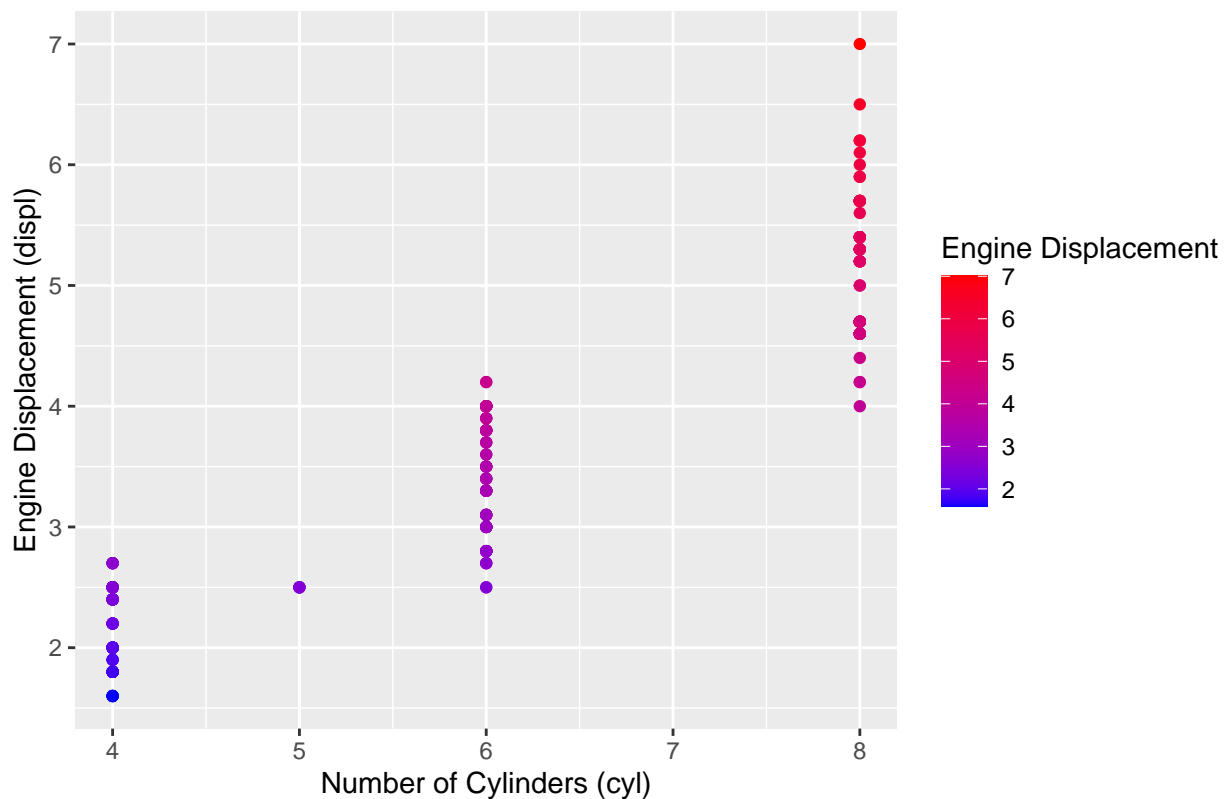
```r
traffic <- read.csv("/cloud/project/worksheet#4/traffic.csv")
str(traffic)
```

```
## 'data.frame':    48120 obs. of  4 variables:
##  $ DateTime: chr  "2015-11-01 00:00:00" "2015-11-01 01:00:00" "2015-11-01 02:00:00" "2015-11-01 03:00
##  $ Junction: int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Vehicles: int  15 13 10 7 9 6 9 8 11 12 ...
##  $ ID      : num  2.02e+10 2.02e+10 2.02e+10 2.02e+10 2.02e+10 ...
```

```r
ggplot(mpg_data, aes(x = displ, y = hwy, color = cty)) +
  geom_point() +
  labs(title = "Relationship between Engine Displacement, Highway MPG, and City MPG",
       x = "Engine Displacement (displ)",
       y = "Highway Miles per Gallon (hwy)",
       color = "City MPG (cty)") +
  scale_color_gradient(low = "blue", high = "red")
```

Relationship between Engine Displacement, Highway MPG, and City MPG

6.b
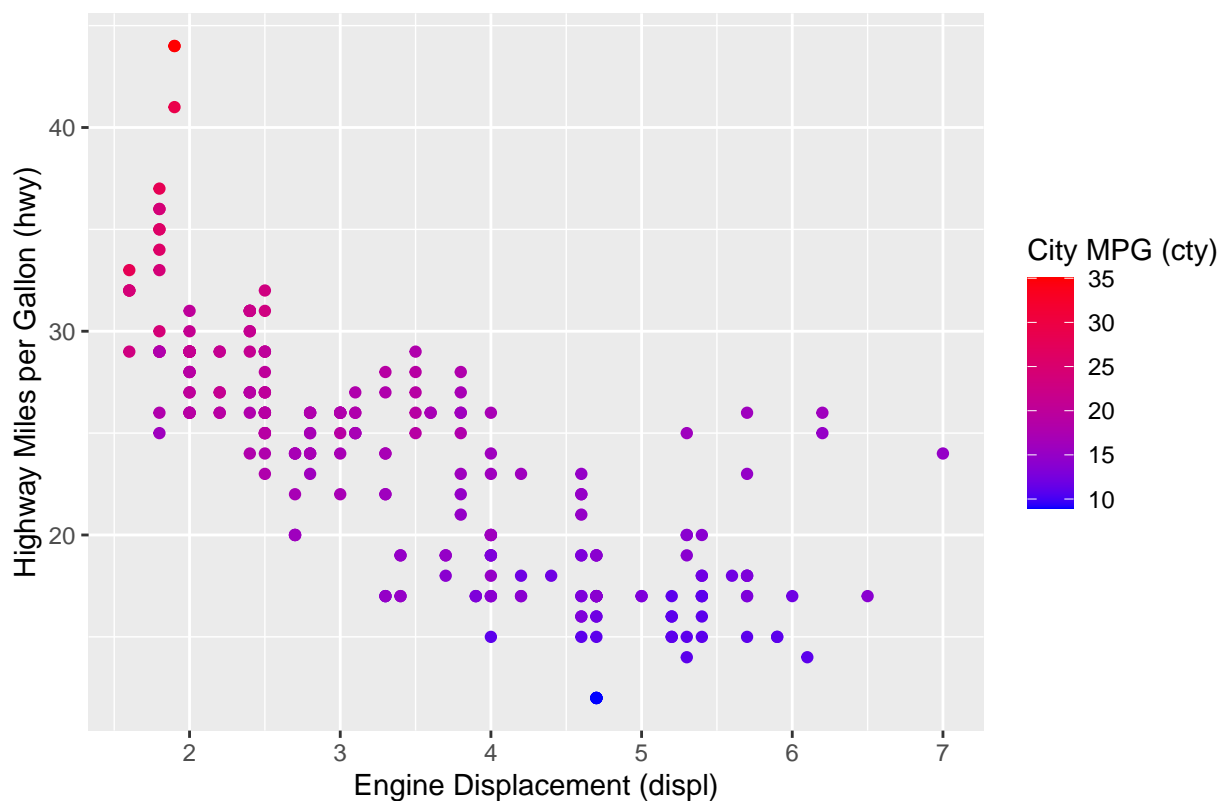
```r
junction <- subset(traffic, select = Junction)
head(junction)
```

```
##   Junction
## 1        1
## 2        1
## 3        1
## 4        1
## 5        1
## 6        1
```
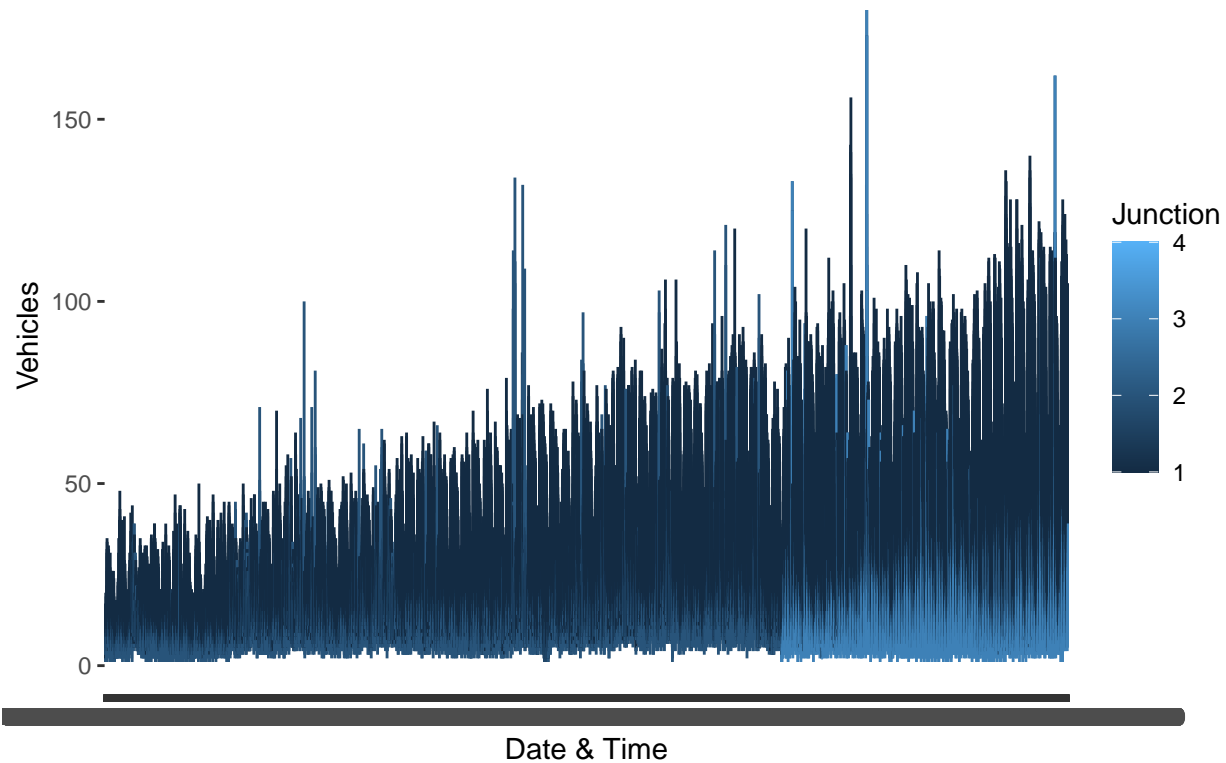
```r
tail(junction)
```

```
##       Junction
## 48115        4
## 48116        4
## 48117        4
## 48118        4
## 48119        4
## 48120        4
```

6.c

```r
library(ggplot2)
ggplot(traffic, aes(x = DateTime, y = Vehicles, color = Junction)) +
  geom_line() +
  labs(title = "Traffic Counts by Junction", x = "Date & Time", y = "Vehicles")
```

Traffic Counts by Junction

```r
library("readxl")
alexa <- read_xlsx("/cloud/project/worksheet#4/alexa_file.xlsx")
```

7.a

```r
nrow(alexa)
```

```
## [1] 3150
```

```r
ncol(alexa)
```

```
## [1] 5
```

7.b

```r
library(dplyr)
variationTotal <- alexa %>%
  group_by(variation) %>%
  summarize(total = n())
print(variationTotal)
```

```
## # A tibble: 16 x 2
##    variation            total
##    <chr>                <int>
##  1 Black                  261
##  2 Black  Dot            516
##  3 Black  Plus           270
##  4 Black  Show           265
##  5 Black  Spot           241
##  6 Charcoal Fabric        430
```

```
##  7 Configuration: Fire TV Stick    350
##  8 Heather Gray Fabric             157
##  9 Oak Finish                       14
## 10 Sandstone Fabric                 90
## 11 Walnut Finish                     9
## 12 White                           91
## 13 White  Dot                      184
## 14 White  Plus                      78
## 15 White  Show                      85
## 16 White  Spot                     109
```

7.c

```r
ggplot(variationTotal, aes(x = variation, y = total, fill = variation)) +
  geom_bar(stat = "identity") +
  labs(title = "Total Variations", x = "Variation", y = "Total") +
  theme_minimal()
```


7.d
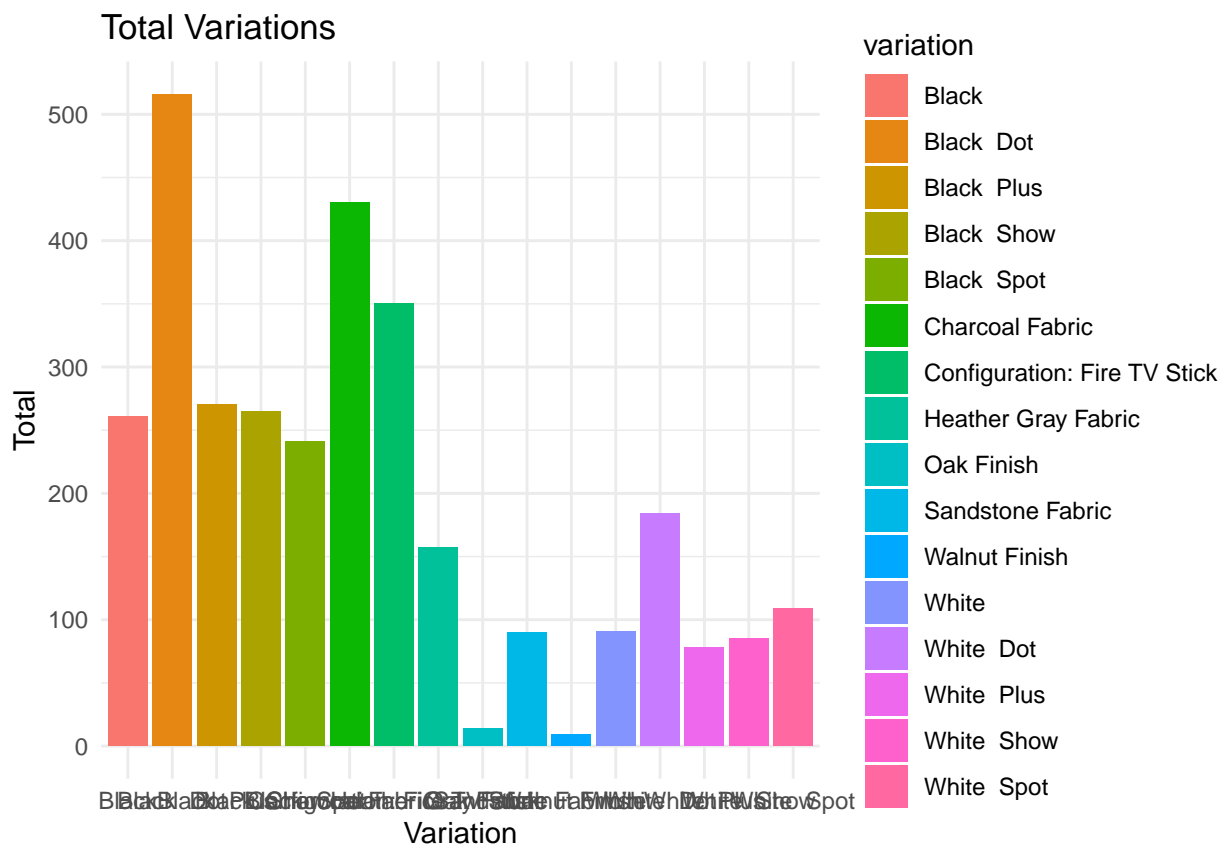
```r
library(dplyr)
no_of_verified_reviews <- alexa %>%
  group_by(date) %>%
  summarize(count = n()) %>%
  arrange(date)
```

```r
library(ggplot2)
ggplot(no_of_verified_reviews, aes(x = date, y = count)) +
  geom_line(color = "red") +
  labs(title = "Verified Reviews Over Time", x = "Date", y = "Verified Reviews") +
```

```
  theme_minimal()
```

Verified Reviews Over Time

7.e

```
variationRating <- alexa %>%
  group_by(variation) %>%
  summarize(avg_rating = mean(rating, na.rm = TRUE)) %>%
  arrange(desc(avg_rating))
print(variationRating)
```

```
## # A tibble: 16 x 2
##    variation                avg_rating
##    <chr>                         <dbl>
##  1 Walnut Finish                  4.89
##  2 Oak Finish                     4.86
##  3 Charcoal Fabric                4.73
##  4 Heather Gray Fabric            4.69
##  5 Configuration: Fire TV Stick   4.59
##  6 Black  Show                    4.49
##  7 Black  Dot                     4.45
##  8 White  Dot                     4.42
##  9 Black  Plus                    4.37
## 10 White  Plus                    4.36
## 11 Sandstone Fabric               4.36
## 12 White  Spot                    4.31
## 13 Black  Spot                    4.31
## 14 White  Show                    4.28
## 15 Black                          4.23
```

```
## 16 White                                        4.14
```
```
ggplot(variationRating, aes(x = reorder(variation, avg_rating), y = avg_rating, fill = variation)) +
  geom_bar(stat = "identity") +
  labs(title = "Average Ratings by Variation", x = "Variation", y = "Average Rating") +
  coord_flip()
```