RWorksheet_Trongoy#4c

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1.

a.

```
library(ggplot2)
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
```

```
data(mpg)
write.csv(mpg, "mpg_data.csv", row.names = FALSE)
mpg_data <- read.csv("mpg_data.csv")
mpg_data
```

```
##     manufacturer                model displ year cyl      trans drv cty hwy
## 1           audi                   a4   1.8 1999   4   auto(l5)   f  18  29
## 2           audi                   a4   1.8 1999   4 manual(m5)   f  21  29
## 3           audi                   a4   2.0 2008   4 manual(m6)   f  20  31
## 4           audi                   a4   2.0 2008   4   auto(av)   f  21  30
## 5           audi                   a4   2.8 1999   6   auto(l5)   f  16  26
## 6           audi                   a4   2.8 1999   6 manual(m5)   f  18  26
## 7           audi                   a4   3.1 2008   6   auto(av)   f  18  27
## 8           audi            a4 quattro   1.8 1999   4 manual(m5)   4  18  26
## 9           audi            a4 quattro   1.8 1999   4   auto(l5)   4  16  25
## 10          audi            a4 quattro   2.0 2008   4 manual(m6)   4  20  28
## 11          audi            a4 quattro   2.0 2008   4   auto(s6)   4  19  27
## 12          audi            a4 quattro   2.8 1999   6   auto(l5)   4  15  25
## 13          audi            a4 quattro   2.8 1999   6 manual(m5)   4  17  25
## 14          audi            a4 quattro   3.1 2008   6   auto(s6)   4  17  25
## 15          audi            a4 quattro   3.1 2008   6 manual(m6)   4  15  25
## 16          audi            a6 quattro   2.8 1999   6   auto(l5)   4  15  24
## 17          audi            a6 quattro   3.1 2008   6   auto(s6)   4  17  25
## 18          audi            a6 quattro   4.2 2008   8   auto(s6)   4  16  23
## 19     chevrolet     c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  14  20
## 20     chevrolet     c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  11  15
## 21     chevrolet     c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  14  20
## 22     chevrolet     c1500 suburban 2wd   5.7 1999   8   auto(l4)   r  13  17
```

```
## 23     chevrolet     c1500 suburban 2wd   6.0 2008   8   auto(l4)   r  12  17
## 24     chevrolet              corvette   5.7 1999   8 manual(m6)   r  16  26
## 25     chevrolet              corvette   5.7 1999   8   auto(l4)   r  15  23
## 26     chevrolet              corvette   6.2 2008   8 manual(m6)   r  16  26
## 27     chevrolet              corvette   6.2 2008   8   auto(s6)   r  15  25
## 28     chevrolet              corvette   7.0 2008   8 manual(m6)   r  15  24
## 29     chevrolet        k1500 tahoe 4wd   5.3 2008   8   auto(l4)   4  14  19
## 30     chevrolet        k1500 tahoe 4wd   5.3 2008   8   auto(l4)   4  11  14
## 31     chevrolet        k1500 tahoe 4wd   5.7 1999   8   auto(l4)   4  11  15
## 32     chevrolet        k1500 tahoe 4wd   6.5 1999   8   auto(l4)   4  14  17
## 33     chevrolet                 malibu   2.4 1999   4   auto(l4)   f  19  27
## 34     chevrolet                 malibu   2.4 2008   4   auto(l4)   f  22  30
## 35     chevrolet                 malibu   3.1 1999   6   auto(l4)   f  18  26
## 36     chevrolet                 malibu   3.5 2008   6   auto(l4)   f  18  29
## 37     chevrolet                 malibu   3.6 2008   6   auto(s6)   f  17  26
## 38         dodge            caravan 2wd   2.4 1999   4   auto(l3)   f  18  24
## 39         dodge            caravan 2wd   3.0 1999   6   auto(l4)   f  17  24
## 40         dodge            caravan 2wd   3.3 1999   6   auto(l4)   f  16  22
## 41         dodge            caravan 2wd   3.3 1999   6   auto(l4)   f  16  22
## 42         dodge            caravan 2wd   3.3 2008   6   auto(l4)   f  17  24
## 43         dodge            caravan 2wd   3.3 2008   6   auto(l4)   f  17  24
## 44         dodge            caravan 2wd   3.3 2008   6   auto(l4)   f  11  17
## 45         dodge            caravan 2wd   3.8 1999   6   auto(l4)   f  15  22
## 46         dodge            caravan 2wd   3.8 1999   6   auto(l4)   f  15  21
## 47         dodge            caravan 2wd   3.8 2008   6   auto(l6)   f  16  23
## 48         dodge            caravan 2wd   4.0 2008   6   auto(l6)   f  16  23
## 49         dodge      dakota pickup 4wd   3.7 2008   6 manual(m6)   4  15  19
## 50         dodge      dakota pickup 4wd   3.7 2008   6   auto(l4)   4  14  18
## 51         dodge      dakota pickup 4wd   3.9 1999   6   auto(l4)   4  13  17
## 52         dodge      dakota pickup 4wd   3.9 1999   6 manual(m5)   4  14  17
## 53         dodge      dakota pickup 4wd   4.7 2008   8   auto(l5)   4  14  19
## 54         dodge      dakota pickup 4wd   4.7 2008   8   auto(l5)   4  14  19
## 55         dodge      dakota pickup 4wd   4.7 2008   8   auto(l5)   4   9  12
## 56         dodge      dakota pickup 4wd   5.2 1999   8 manual(m5)   4  11  17
## 57         dodge      dakota pickup 4wd   5.2 1999   8   auto(l4)   4  11  15
## 58         dodge            durango 4wd   3.9 1999   6   auto(l4)   4  13  17
## 59         dodge            durango 4wd   4.7 2008   8   auto(l5)   4  13  17
## 60         dodge            durango 4wd   4.7 2008   8   auto(l5)   4   9  12
## 61         dodge            durango 4wd   4.7 2008   8   auto(l5)   4  13  17
## 62         dodge            durango 4wd   5.2 1999   8   auto(l4)   4  11  16
## 63         dodge            durango 4wd   5.7 2008   8   auto(l5)   4  13  18
## 64         dodge            durango 4wd   5.9 1999   8   auto(l4)   4  11  15
## 65         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4  12  16
## 66         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4   9  12
## 67         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4  13  17
## 68         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4  13  17
## 69         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4  12  16
## 70         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4   9  12
## 71         dodge    ram 1500 pickup 4wd   5.2 1999   8   auto(l4)   4  11  15
## 72         dodge    ram 1500 pickup 4wd   5.2 1999   8 manual(m5)   4  11  16
## 73         dodge    ram 1500 pickup 4wd   5.7 2008   8   auto(l5)   4  13  17
## 74         dodge    ram 1500 pickup 4wd   5.9 1999   8   auto(l4)   4  11  15
## 75          ford         expedition 2wd   4.6 1999   8   auto(l4)   r  11  17
## 76          ford         expedition 2wd   5.4 1999   8   auto(l4)   r  11  17
```

```
## 77          ford         expedition 2wd   5.4 2008   8   auto(l6)   r  12  18
## 78          ford           explorer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 79          ford           explorer 4wd   4.0 1999   6 manual(m5)   4  15  19
## 80          ford           explorer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 81          ford           explorer 4wd   4.0 2008   6   auto(l5)   4  13  19
## 82          ford           explorer 4wd   4.6 2008   8   auto(l6)   4  13  19
## 83          ford           explorer 4wd   5.0 1999   8   auto(l4)   4  13  17
## 84          ford        f150 pickup 4wd   4.2 1999   6   auto(l4)   4  14  17
## 85          ford        f150 pickup 4wd   4.2 1999   6 manual(m5)   4  14  17
## 86          ford        f150 pickup 4wd   4.6 1999   8 manual(m5)   4  13  16
## 87          ford        f150 pickup 4wd   4.6 1999   8   auto(l4)   4  13  16
## 88          ford        f150 pickup 4wd   4.6 2008   8   auto(l4)   4  13  17
## 89          ford        f150 pickup 4wd   5.4 1999   8   auto(l4)   4  11  15
## 90          ford        f150 pickup 4wd   5.4 2008   8   auto(l4)   4  13  17
## 91          ford                mustang   3.8 1999   6 manual(m5)   r  18  26
## 92          ford                mustang   3.8 1999   6   auto(l4)   r  18  25
## 93          ford                mustang   4.0 2008   6 manual(m5)   r  17  26
## 94          ford                mustang   4.0 2008   6   auto(l5)   r  16  24
## 95          ford                mustang   4.6 1999   8   auto(l4)   r  15  21
## 96          ford                mustang   4.6 1999   8 manual(m5)   r  15  22
## 97          ford                mustang   4.6 2008   8 manual(m5)   r  15  23
## 98          ford                mustang   4.6 2008   8   auto(l5)   r  15  22
## 99          ford                mustang   5.4 2008   8 manual(m6)   r  14  20
## 100        honda                  civic   1.6 1999   4 manual(m5)   f  28  33
## 101        honda                  civic   1.6 1999   4   auto(l4)   f  24  32
## 102        honda                  civic   1.6 1999   4 manual(m5)   f  25  32
## 103        honda                  civic   1.6 1999   4 manual(m5)   f  23  29
## 104        honda                  civic   1.6 1999   4   auto(l4)   f  24  32
## 105        honda                  civic   1.8 2008   4 manual(m5)   f  26  34
## 106        honda                  civic   1.8 2008   4   auto(l5)   f  25  36
## 107        honda                  civic   1.8 2008   4   auto(l5)   f  24  36
## 108        honda                  civic   2.0 2008   4 manual(m6)   f  21  29
## 109      hyundai                 sonata   2.4 1999   4   auto(l4)   f  18  26
## 110      hyundai                 sonata   2.4 1999   4 manual(m5)   f  18  27
## 111      hyundai                 sonata   2.4 2008   4   auto(l4)   f  21  30
## 112      hyundai                 sonata   2.4 2008   4 manual(m5)   f  21  31
## 113      hyundai                 sonata   2.5 1999   6   auto(l4)   f  18  26
## 114      hyundai                 sonata   2.5 1999   6 manual(m5)   f  18  26
## 115      hyundai                 sonata   3.3 2008   6   auto(l5)   f  19  28
## 116      hyundai                tiburon   2.0 1999   4   auto(l4)   f  19  26
## 117      hyundai                tiburon   2.0 1999   4 manual(m5)   f  19  29
## 118      hyundai                tiburon   2.0 2008   4 manual(m5)   f  20  28
## 119      hyundai                tiburon   2.0 2008   4   auto(l4)   f  20  27
## 120      hyundai                tiburon   2.7 2008   6   auto(l4)   f  17  24
## 121      hyundai                tiburon   2.7 2008   6 manual(m6)   f  16  24
## 122      hyundai                tiburon   2.7 2008   6 manual(m5)   f  17  24
## 123         jeep     grand cherokee 4wd   3.0 2008   6   auto(l5)   4  17  22
## 124         jeep     grand cherokee 4wd   3.7 2008   6   auto(l5)   4  15  19
## 125         jeep     grand cherokee 4wd   4.0 1999   6   auto(l4)   4  15  20
## 126         jeep     grand cherokee 4wd   4.7 1999   8   auto(l4)   4  14  17
## 127         jeep     grand cherokee 4wd   4.7 2008   8   auto(l5)   4   9  12
## 128         jeep     grand cherokee 4wd   4.7 2008   8   auto(l5)   4  14  19
## 129         jeep     grand cherokee 4wd   5.7 2008   8   auto(l5)   4  13  18
## 130         jeep     grand cherokee 4wd   6.1 2008   8   auto(l5)   4  11  14
```

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## 131   land rover           range rover   4.0 1999   8   auto(l4)   4  11  15
## 132   land rover           range rover   4.2 2008   8   auto(s6)   4  12  18
## 133   land rover           range rover   4.4 2008   8   auto(s6)   4  12  18
## 134   land rover           range rover   4.6 1999   8   auto(l4)   4  11  15
## 135      lincoln         navigator 2wd   5.4 1999   8   auto(l4)   r  11  17
## 136      lincoln         navigator 2wd   5.4 1999   8   auto(l4)   r  11  16
## 137      lincoln         navigator 2wd   5.4 2008   8   auto(l6)   r  12  18
## 138      mercury       mountaineer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 139      mercury       mountaineer 4wd   4.0 2008   6   auto(l5)   4  13  19
## 140      mercury       mountaineer 4wd   4.6 2008   8   auto(l6)   4  13  19
## 141      mercury       mountaineer 4wd   5.0 1999   8   auto(l4)   4  13  17
## 142       nissan                altima   2.4 1999   4 manual(m5)   f  21  29
## 143       nissan                altima   2.4 1999   4   auto(l4)   f  19  27
## 144       nissan                altima   2.5 2008   4   auto(av)   f  23  31
## 145       nissan                altima   2.5 2008   4 manual(m6)   f  23  32
## 146       nissan                altima   3.5 2008   6 manual(m6)   f  19  27
## 147       nissan                altima   3.5 2008   6   auto(av)   f  19  26
## 148       nissan                maxima   3.0 1999   6   auto(l4)   f  18  26
## 149       nissan                maxima   3.0 1999   6 manual(m5)   f  19  25
## 150       nissan                maxima   3.5 2008   6   auto(av)   f  19  25
## 151       nissan         pathfinder 4wd   3.3 1999   6   auto(l4)   4  14  17
## 152       nissan         pathfinder 4wd   3.3 1999   6 manual(m5)   4  15  17
## 153       nissan         pathfinder 4wd   4.0 2008   6   auto(l5)   4  14  20
## 154       nissan         pathfinder 4wd   5.6 2008   8   auto(s5)   4  12  18
## 155      pontiac             grand prix   3.1 1999   6   auto(l4)   f  18  26
## 156      pontiac             grand prix   3.8 1999   6   auto(l4)   f  16  26
## 157      pontiac             grand prix   3.8 1999   6   auto(l4)   f  17  27
## 158      pontiac             grand prix   3.8 2008   6   auto(l4)   f  18  28
## 159      pontiac             grand prix   5.3 2008   8   auto(s4)   f  16  25
## 160       subaru           forester awd   2.5 1999   4 manual(m5)   4  18  25
## 161       subaru           forester awd   2.5 1999   4   auto(l4)   4  18  24
## 162       subaru           forester awd   2.5 2008   4 manual(m5)   4  20  27
## 163       subaru           forester awd   2.5 2008   4 manual(m5)   4  19  25
## 164       subaru           forester awd   2.5 2008   4   auto(l4)   4  20  26
## 165       subaru           forester awd   2.5 2008   4   auto(l4)   4  18  23
## 166       subaru            impreza awd   2.2 1999   4   auto(l4)   4  21  26
## 167       subaru            impreza awd   2.2 1999   4 manual(m5)   4  19  26
## 168       subaru            impreza awd   2.5 1999   4 manual(m5)   4  19  26
## 169       subaru            impreza awd   2.5 1999   4   auto(l4)   4  19  26
## 170       subaru            impreza awd   2.5 2008   4   auto(s4)   4  20  25
## 171       subaru            impreza awd   2.5 2008   4   auto(s4)   4  20  27
## 172       subaru            impreza awd   2.5 2008   4 manual(m5)   4  19  25
## 173       subaru            impreza awd   2.5 2008   4 manual(m5)   4  20  27
## 174       toyota            4runner 4wd   2.7 1999   4 manual(m5)   4  15  20
## 175       toyota            4runner 4wd   2.7 1999   4   auto(l4)   4  16  20
## 176       toyota            4runner 4wd   3.4 1999   6   auto(l4)   4  15  19
## 177       toyota            4runner 4wd   3.4 1999   6 manual(m5)   4  15  17
## 178       toyota            4runner 4wd   4.0 2008   6   auto(l5)   4  16  20
## 179       toyota            4runner 4wd   4.7 2008   8   auto(l5)   4  14  17
## 180       toyota                 camry   2.2 1999   4 manual(m5)   f  21  29
## 181       toyota                 camry   2.2 1999   4   auto(l4)   f  21  27
## 182       toyota                 camry   2.4 2008   4 manual(m5)   f  21  31
## 183       toyota                 camry   2.4 2008   4   auto(l5)   f  21  31
## 184       toyota                 camry   3.0 1999   6   auto(l4)   f  18  26
```

```
## 185       toyota                 camry   3.0 1999   6 manual(m5)   f  18  26
## 186       toyota                 camry   3.5 2008   6   auto(s6)   f  19  28
## 187       toyota           camry solara   2.2 1999   4   auto(l4)   f  21  27
## 188       toyota           camry solara   2.2 1999   4 manual(m5)   f  21  29
## 189       toyota           camry solara   2.4 2008   4 manual(m5)   f  21  31
## 190       toyota           camry solara   2.4 2008   4   auto(s5)   f  22  31
## 191       toyota           camry solara   3.0 1999   6   auto(l4)   f  18  26
## 192       toyota           camry solara   3.0 1999   6 manual(m5)   f  18  26
## 193       toyota           camry solara   3.3 2008   6   auto(s5)   f  18  27
## 194       toyota                corolla   1.8 1999   4   auto(l3)   f  24  30
## 195       toyota                corolla   1.8 1999   4   auto(l4)   f  24  33
## 196       toyota                corolla   1.8 1999   4 manual(m5)   f  26  35
## 197       toyota                corolla   1.8 2008   4 manual(m5)   f  28  37
## 198       toyota                corolla   1.8 2008   4   auto(l4)   f  26  35
## 199       toyota land cruiser wagon 4wd   4.7 1999   8   auto(l4)   4  11  15
## 200       toyota land cruiser wagon 4wd   5.7 2008   8   auto(s6)   4  13  18
## 201       toyota      toyota tacoma 4wd   2.7 1999   4 manual(m5)   4  15  20
## 202       toyota      toyota tacoma 4wd   2.7 1999   4   auto(l4)   4  16  20
## 203       toyota      toyota tacoma 4wd   2.7 2008   4 manual(m5)   4  17  22
## 204       toyota      toyota tacoma 4wd   3.4 1999   6 manual(m5)   4  15  17
## 205       toyota      toyota tacoma 4wd   3.4 1999   6   auto(l4)   4  15  19
## 206       toyota      toyota tacoma 4wd   4.0 2008   6 manual(m6)   4  15  18
## 207       toyota      toyota tacoma 4wd   4.0 2008   6   auto(l5)   4  16  20
## 208   volkswagen                   gti   2.0 1999   4 manual(m5)   f  21  29
## 209   volkswagen                   gti   2.0 1999   4   auto(l4)   f  19  26
## 210   volkswagen                   gti   2.0 2008   4 manual(m6)   f  21  29
## 211   volkswagen                   gti   2.0 2008   4   auto(s6)   f  22  29
## 212   volkswagen                   gti   2.8 1999   6 manual(m5)   f  17  24
## 213   volkswagen                 jetta   1.9 1999   4 manual(m5)   f  33  44
## 214   volkswagen                 jetta   2.0 1999   4 manual(m5)   f  21  29
## 215   volkswagen                 jetta   2.0 1999   4   auto(l4)   f  19  26
## 216   volkswagen                 jetta   2.0 2008   4   auto(s6)   f  22  29
## 217   volkswagen                 jetta   2.0 2008   4 manual(m6)   f  21  29
## 218   volkswagen                 jetta   2.5 2008   5   auto(s6)   f  21  29
## 219   volkswagen                 jetta   2.5 2008   5 manual(m5)   f  21  29
## 220   volkswagen                 jetta   2.8 1999   6   auto(l4)   f  16  23
## 221   volkswagen                 jetta   2.8 1999   6 manual(m5)   f  17  24
## 222   volkswagen            new beetle   1.9 1999   4 manual(m5)   f  35  44
## 223   volkswagen            new beetle   1.9 1999   4   auto(l4)   f  29  41
## 224   volkswagen            new beetle   2.0 1999   4 manual(m5)   f  21  29
## 225   volkswagen            new beetle   2.0 1999   4   auto(l4)   f  19  26
## 226   volkswagen            new beetle   2.5 2008   5 manual(m5)   f  20  28
## 227   volkswagen            new beetle   2.5 2008   5   auto(s6)   f  20  29
## 228   volkswagen                passat   1.8 1999   4 manual(m5)   f  21  29
## 229   volkswagen                passat   1.8 1999   4   auto(l5)   f  18  29
## 230   volkswagen                passat   2.0 2008   4   auto(s6)   f  19  28
## 231   volkswagen                passat   2.0 2008   4 manual(m6)   f  21  29
## 232   volkswagen                passat   2.8 1999   6   auto(l5)   f  16  26
## 233   volkswagen                passat   2.8 1999   6 manual(m5)   f  18  26
## 234   volkswagen                passat   3.6 2008   6   auto(s6)   f  17  26
##     fl      class
## 1    p    compact
## 2    p    compact
## 3    p    compact
```

```
## 4    p    compact
## 5    p    compact
## 6    p    compact
## 7    p    compact
## 8    p    compact
## 9    p    compact
## 10   p    compact
## 11   p    compact
## 12   p    compact
## 13   p    compact
## 14   p    compact
## 15   p    compact
## 16   p    midsize
## 17   p    midsize
## 18   p    midsize
## 19   r        suv
## 20   e        suv
## 21   r        suv
## 22   r        suv
## 23   r        suv
## 24   p    2seater
## 25   p    2seater
## 26   p    2seater
## 27   p    2seater
## 28   p    2seater
## 29   r        suv
## 30   e        suv
## 31   r        suv
## 32   d        suv
## 33   r    midsize
## 34   r    midsize
## 35   r    midsize
## 36   r    midsize
## 37   r    midsize
## 38   r    minivan
## 39   r    minivan
## 40   r    minivan
## 41   r    minivan
## 42   r    minivan
## 43   r    minivan
## 44   e    minivan
## 45   r    minivan
## 46   r    minivan
## 47   r    minivan
## 48   r    minivan
## 49   r     pickup
## 50   r     pickup
## 51   r     pickup
## 52   r     pickup
## 53   r     pickup
## 54   r     pickup
## 55   e     pickup
## 56   r     pickup
## 57   r     pickup
```

```
## 58   r        suv
## 59   r        suv
## 60   e        suv
## 61   r        suv
## 62   r        suv
## 63   r        suv
## 64   r        suv
## 65   r     pickup
## 66   e     pickup
## 67   r     pickup
## 68   r     pickup
## 69   r     pickup
## 70   e     pickup
## 71   r     pickup
## 72   r     pickup
## 73   r     pickup
## 74   r     pickup
## 75   r        suv
## 76   r        suv
## 77   r        suv
## 78   r        suv
## 79   r        suv
## 80   r        suv
## 81   r        suv
## 82   r        suv
## 83   r        suv
## 84   r     pickup
## 85   r     pickup
## 86   r     pickup
## 87   r     pickup
## 88   r     pickup
## 89   r     pickup
## 90   r     pickup
## 91   r subcompact
## 92   r subcompact
## 93   r subcompact
## 94   r subcompact
## 95   r subcompact
## 96   r subcompact
## 97   r subcompact
## 98   r subcompact
## 99   p subcompact
## 100  r subcompact
## 101  r subcompact
## 102  r subcompact
## 103  p subcompact
## 104  r subcompact
## 105  r subcompact
## 106  r subcompact
## 107  c subcompact
## 108  p subcompact
## 109  r    midsize
## 110  r    midsize
## 111  r    midsize
```

```
## 112  r    midsize
## 113  r    midsize
## 114  r    midsize
## 115  r    midsize
## 116  r subcompact
## 117  r subcompact
## 118  r subcompact
## 119  r subcompact
## 120  r subcompact
## 121  r subcompact
## 122  r subcompact
## 123  d        suv
## 124  r        suv
## 125  r        suv
## 126  r        suv
## 127  e        suv
## 128  r        suv
## 129  r        suv
## 130  p        suv
## 131  p        suv
## 132  r        suv
## 133  r        suv
## 134  p        suv
## 135  r        suv
## 136  p        suv
## 137  r        suv
## 138  r        suv
## 139  r        suv
## 140  r        suv
## 141  r        suv
## 142  r    compact
## 143  r    compact
## 144  r    midsize
## 145  r    midsize
## 146  p    midsize
## 147  p    midsize
## 148  r    midsize
## 149  r    midsize
## 150  p    midsize
## 151  r        suv
## 152  r        suv
## 153  p        suv
## 154  p        suv
## 155  r    midsize
## 156  p    midsize
## 157  r    midsize
## 158  r    midsize
## 159  p    midsize
## 160  r        suv
## 161  r        suv
## 162  r        suv
## 163  p        suv
## 164  r        suv
## 165  p        suv
```

```
## 166  r subcompact
## 167  r subcompact
## 168  r subcompact
## 169  r subcompact
## 170  p    compact
## 171  r    compact
## 172  p    compact
## 173  r    compact
## 174  r        suv
## 175  r        suv
## 176  r        suv
## 177  r        suv
## 178  r        suv
## 179  r        suv
## 180  r    midsize
## 181  r    midsize
## 182  r    midsize
## 183  r    midsize
## 184  r    midsize
## 185  r    midsize
## 186  r    midsize
## 187  r    compact
## 188  r    compact
## 189  r    compact
## 190  r    compact
## 191  r    compact
## 192  r    compact
## 193  r    compact
## 194  r    compact
## 195  r    compact
## 196  r    compact
## 197  r    compact
## 198  r    compact
## 199  r        suv
## 200  r        suv
## 201  r     pickup
## 202  r     pickup
## 203  r     pickup
## 204  r     pickup
## 205  r     pickup
## 206  r     pickup
## 207  r     pickup
## 208  r    compact
## 209  r    compact
## 210  p    compact
## 211  p    compact
## 212  r    compact
## 213  d    compact
## 214  r    compact
## 215  r    compact
## 216  p    compact
## 217  p    compact
## 218  r    compact
## 219  r    compact
```

```
## 220  r    compact
## 221  r    compact
## 222  d subcompact
## 223  d subcompact
## 224  r subcompact
## 225  r subcompact
## 226  r subcompact
## 227  r subcompact
## 228  p    midsize
## 229  p    midsize
## 230  p    midsize
## 231  p    midsize
## 232  p    midsize
## 233  p    midsize
## 234  p    midsize
```

b. the categorical variables are: manufacturer, model, trans(type of transmisionn), drv(type of drive train), fl(type of fuel consumed), class(the type of car)

c. the contiuous vaiables are: displ(the engine displacement), year(manufacturing date), cyl(number pf cylinders), city(city miles per gallon), hwy(highway miles per galon)

2.

a.

```
manufacturer_model_counts <- mpg %>%
  group_by(manufacturer) %>%
  summarise(unique_models = n_distinct(model)) %>%
  arrange(desc(unique_models))

# result
manufacturer_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
```

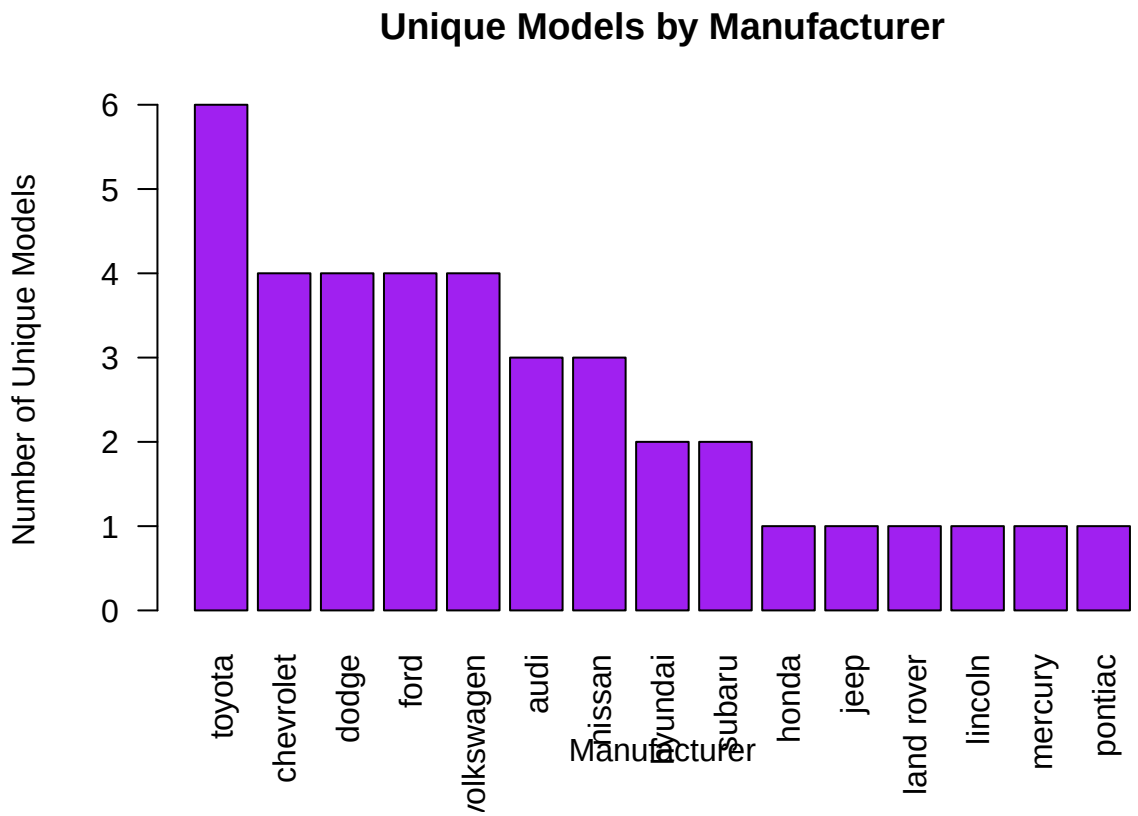
```
model_variations <- mpg %>%
  group_by(model) %>%
  summarise(variations = n()) %>%
  arrange(desc(variations))
```

```
# result
model_variations
```

```
## # A tibble: 38 x 2
##    model               variations
##    <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
```

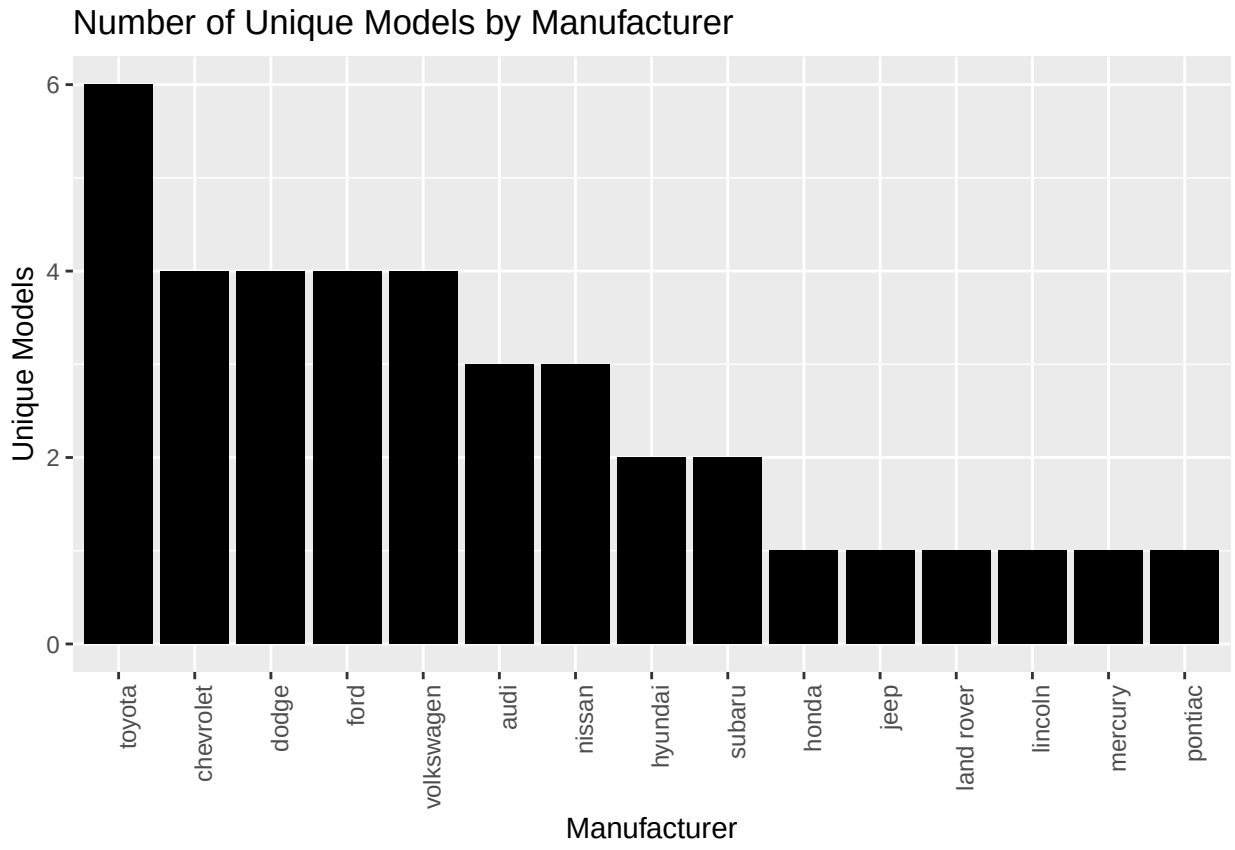
b. using basic plot:

```
barplot(manufacturer_model_counts$unique_models,
        names.arg = manufacturer_model_counts$manufacturer,
        las = 2, col = "purple", main = "Unique Models by Manufacturer",
        xlab = "Manufacturer", ylab = "Number of Unique Models")
```



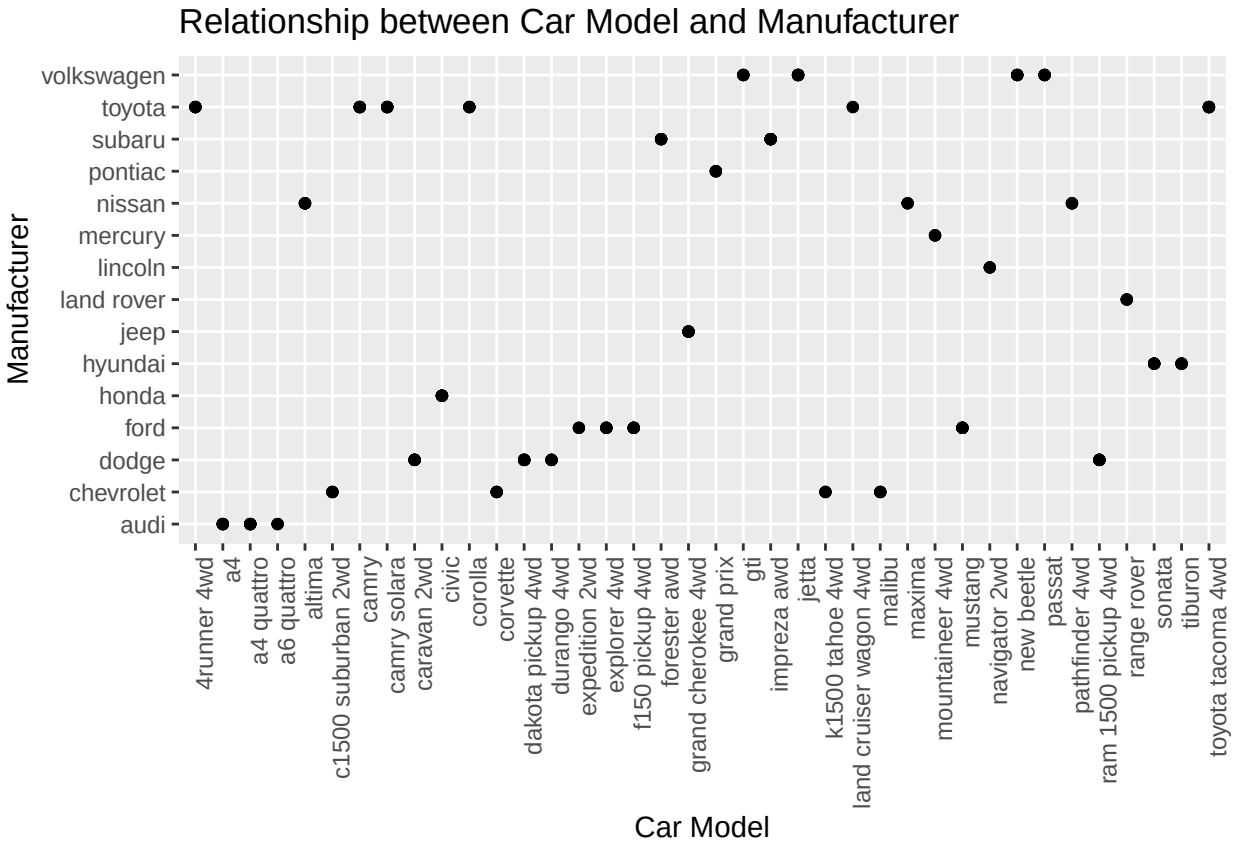
using ggplot2:

```r
library(ggplot2)

ggplot(manufacturer_model_counts, aes(x = reorder(manufacturer, -unique_models), y = unique_models)) +
  geom_bar(stat = "identity", fill = "black") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
  labs(title = "Number of Unique Models by Manufacturer", x = "Manufacturer", y = "Unique Models")
```



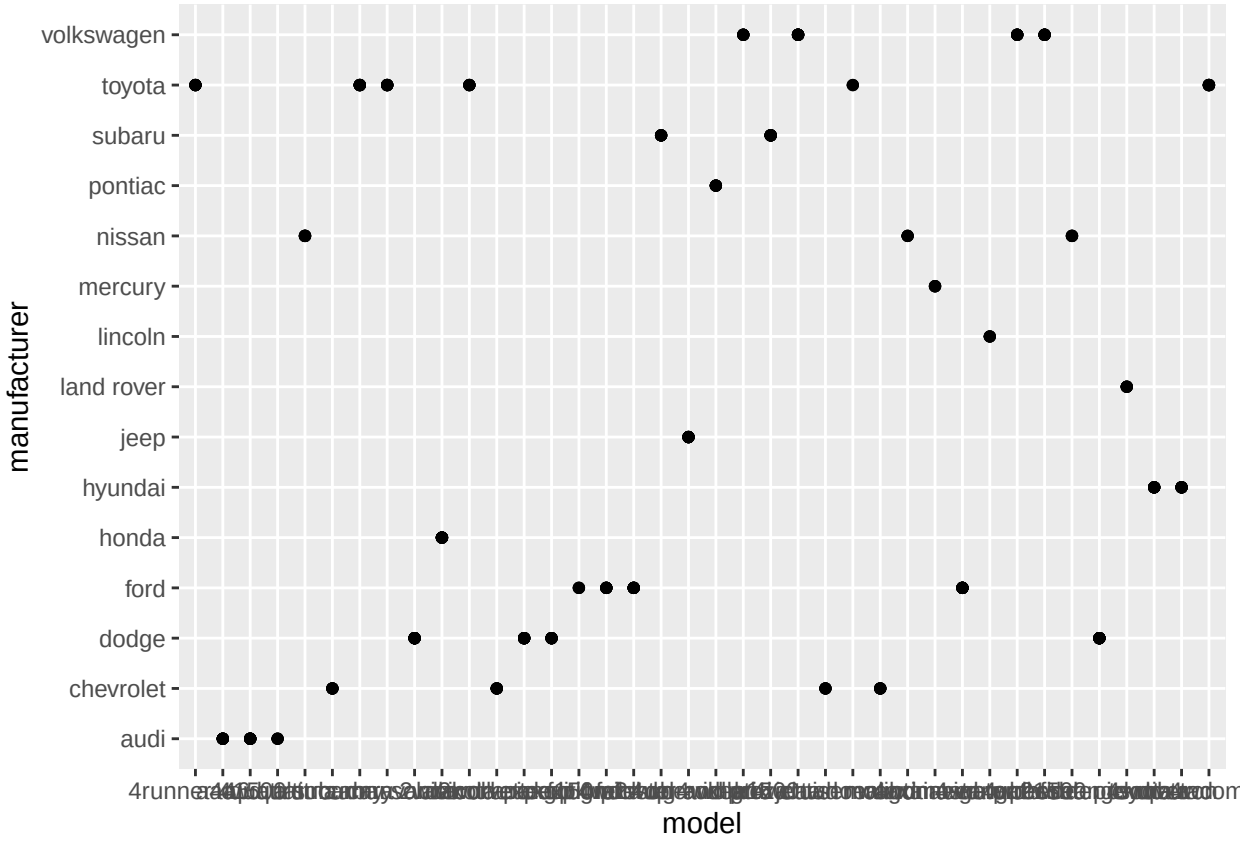
2.

```r
ggplot(mpg, aes(x = model, y = manufacturer)) +
  geom_point() +
  labs(title = "Relationship between Car Model and Manufacturer",
       x = "Car Model",
       y = "Manufacturer") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1))
```



a.

```
ggplot(mpg, aes(model, manufacturer)) + geom_point()
```

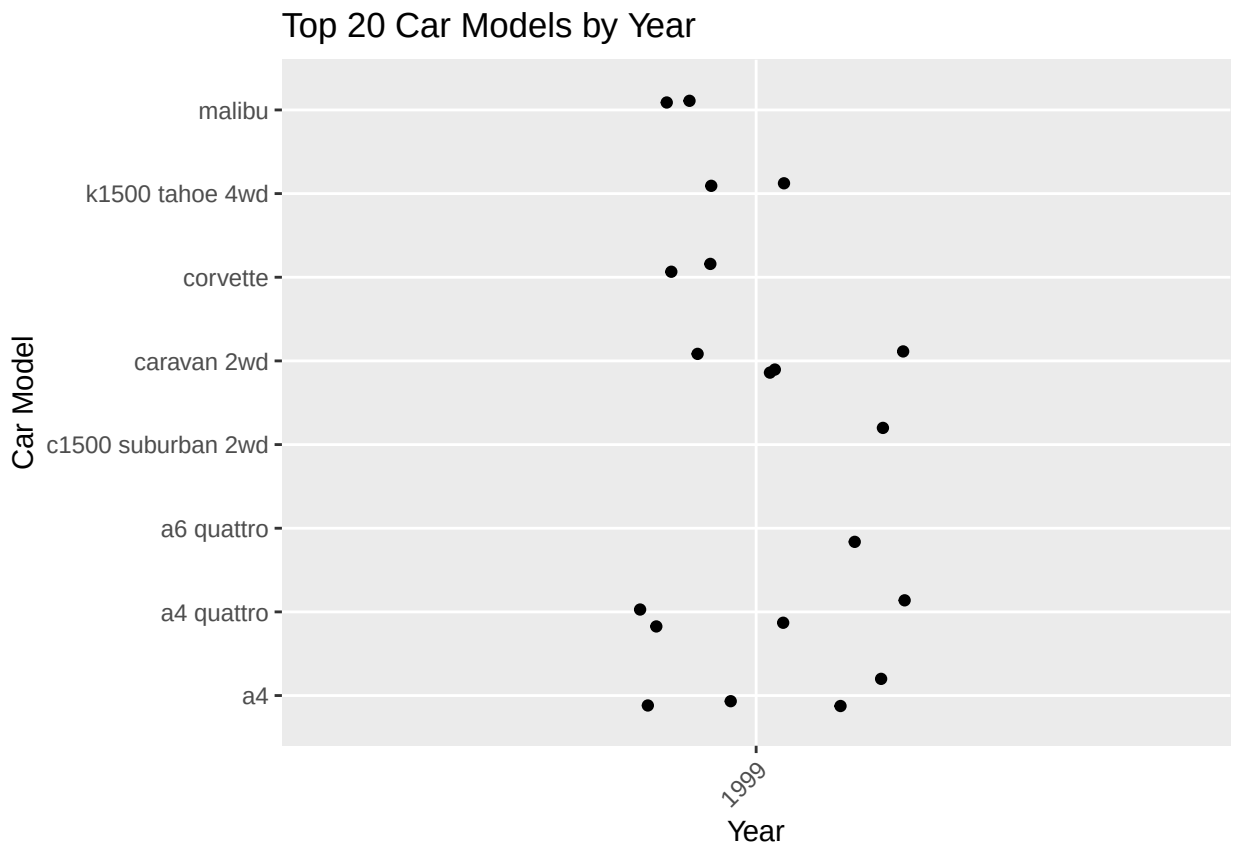


it plotted the relationship between model and manufacturer but the model axis seems to be compressed to the point of being glitchy.

b. The plot gives a basic sense of how car models relate to their manufacturers, but it might not be super helpful as it is right now. If there are a lot of different models and manufacturers, the visualization can get pretty cluttered, making it hard to draw any meaningful insights. It may not convey much useful information at first glance.

3.

```
top_20_mpg <- mpg[order(mpg$year), ][1:20, ]


ggplot(top_20_mpg, aes(x = factor(year), y = model)) +
  geom_jitter(width = 0.2, height = 0.2) +
  labs(title = "Top 20 Car Models by Year",
       x = "Year",
       y = "Car Model") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



4.

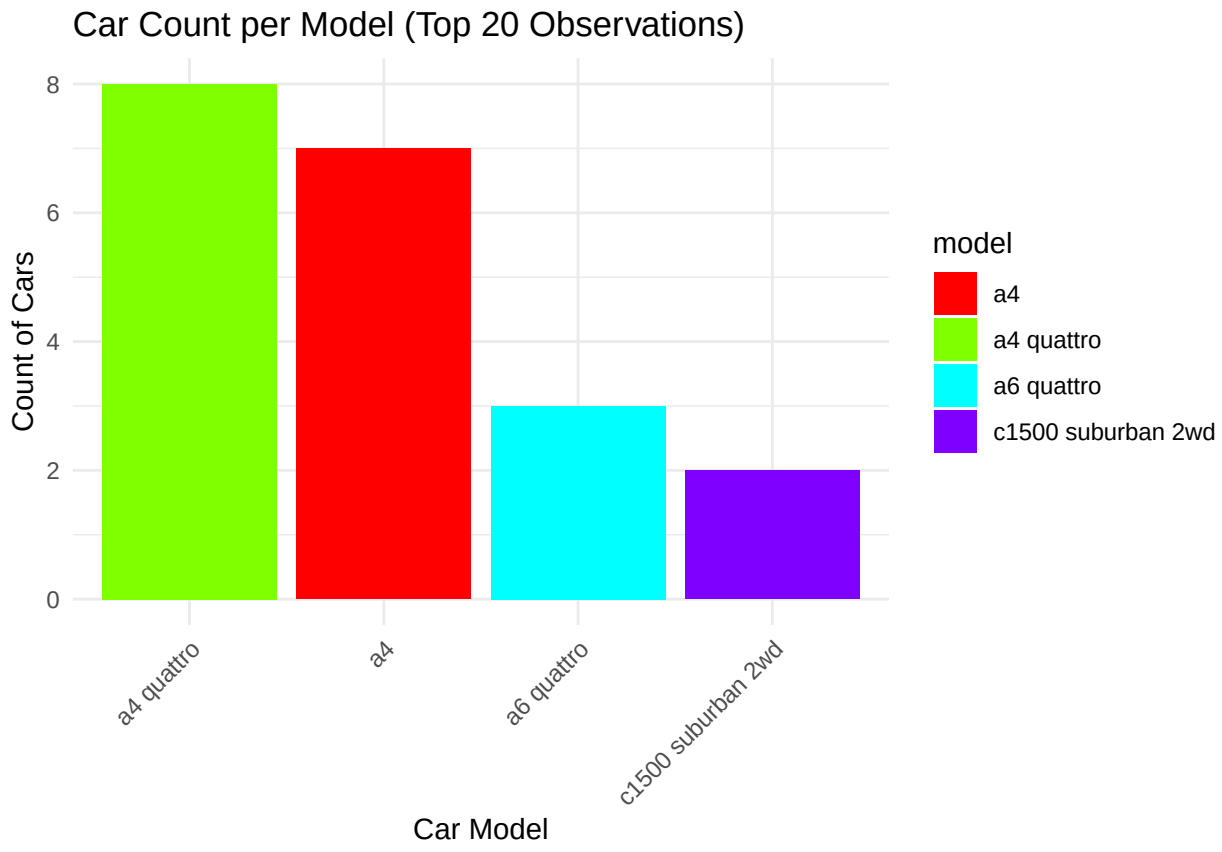
```
car_counts <- mpg %>%
  group_by(model) %>%
  summarise(num_cars = n()) %>%
  arrange(desc(num_cars))

car_counts
```

```
## # A tibble: 38 x 2
##    model               num_cars
##    <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
```

a.

```
library(ggplot2)
library(dplyr)
```

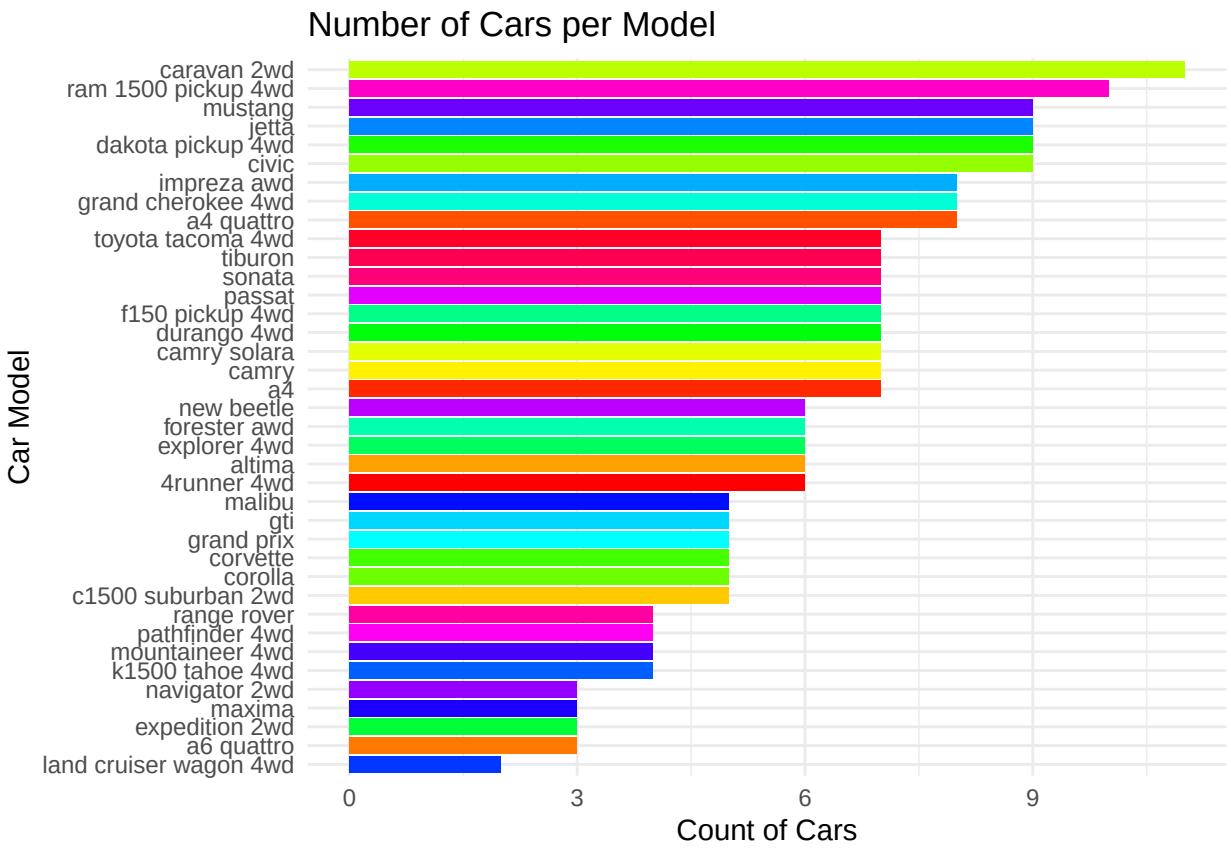
```r
mpg_top20 <- mpg %>% head(20)

model_counts <- mpg_top20 %>%
  group_by(model) %>%
  summarise(car_count = n()) %>%
  arrange(desc(car_count))

ggplot(model_counts, aes(x = reorder(model, -car_count), y = car_count, fill = model)) +
  geom_bar(stat = "identity") +
  labs(title = "Car Count per Model (Top 20 Observations)",
       x = "Car Model",
       y = "Count of Cars") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  scale_fill_manual(values = rainbow(nrow(model_counts)))
```



b.

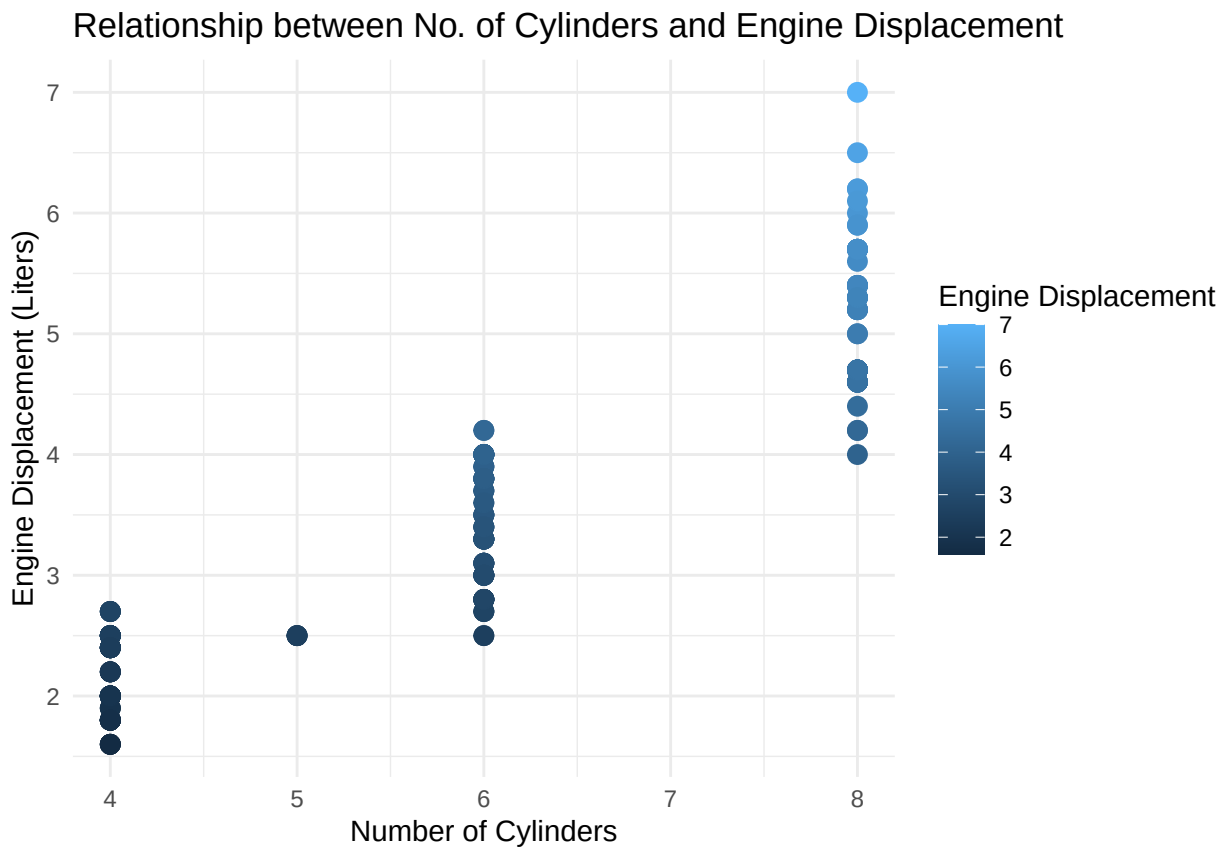
```r
library(ggplot2)
library(dplyr)


model_counts <- mpg %>%
  group_by(model) %>%
```

```
  summarise(car_count = n()) %>%
  arrange(desc(car_count))

ggplot(model_counts, aes(x = reorder(model, car_count), y = car_count, fill = model)) +
  geom_bar(stat = "identity") +
  coord_flip() +  # Flips the coordinates to make horizontal bars
  labs(title = "Number of Cars per Model",
       x = "Car Model",
       y = "Count of Cars") +
  theme_minimal() +
  theme(legend.position = "none") +  # Hide the legend
  scale_fill_manual(values = rainbow(nrow(model_counts)))
```



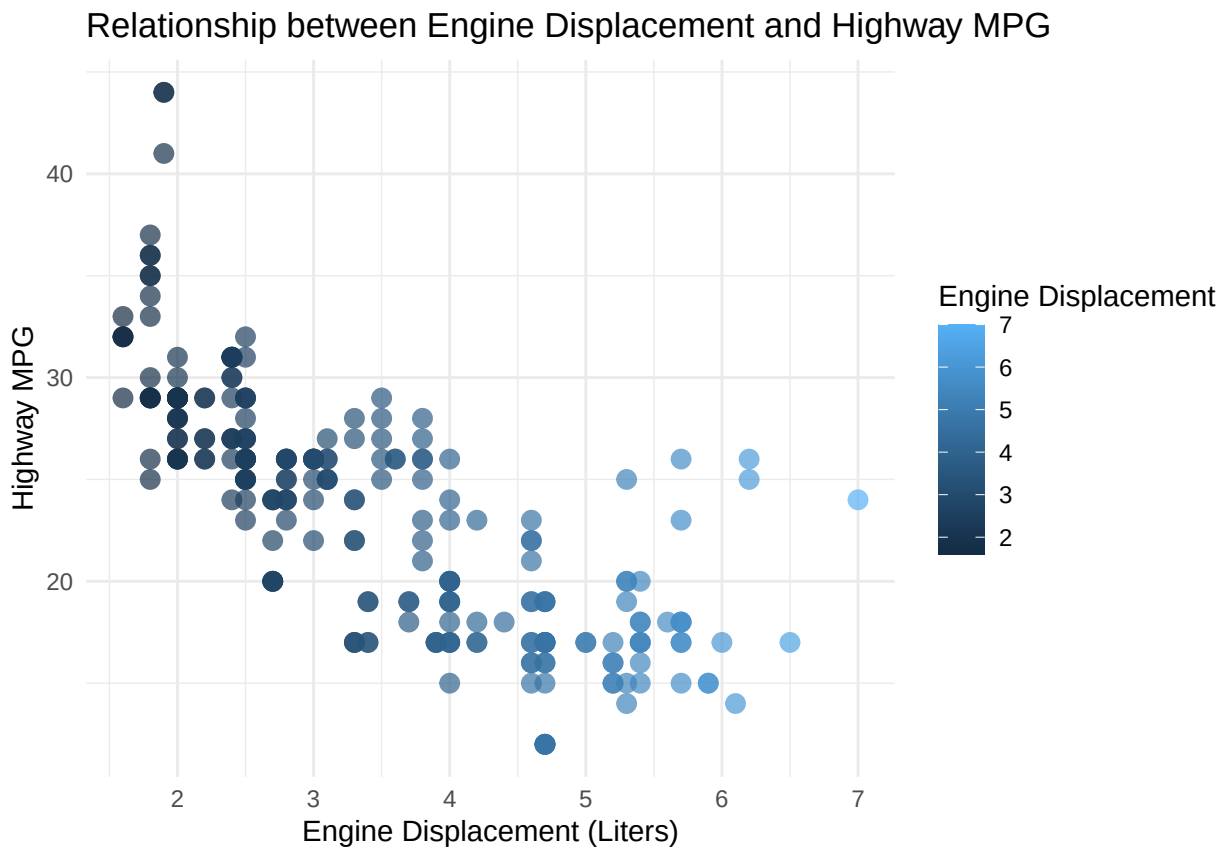
5. a. The relationship between the number of cylinders and engine displacement is generally positive, meaning that as the number of cylinders increases, the engine displacement tends to increase as well. This suggests that cars with more cylinders typically have larger engines in terms of displacement.

```
library(ggplot2)


ggplot(mpg, aes(x = cyl, y = displ, color = displ)) +
  geom_point(size = 3) +
  labs(title = "Relationship between No. of Cylinders and Engine Displacement",
       x = "Number of Cylinders",
       y = "Engine Displacement (Liters)",
       color = "Engine Displacement") +
  theme_minimal()
```



6.1. The scatter plot reveals a negative correlation between engine displacement (displ) and highway miles per gallon (hwy), indicating that as engine displacement increases, highway MPG tends to decrease. This output arises because larger engines typically consume more fuel, leading to lower fuel efficiency on the highway, reflecting the trade-off between engine size and fuel economy in vehicles.

```
library(ggplot2)



ggplot(mpg, aes(x = displ, y = hwy, color = displ)) +
  geom_point(size = 3, alpha = 0.7) +
  labs(title = "Relationship between Engine Displacement and Highway MPG",
       x = "Engine Displacement (Liters)",
       y = "Highway MPG",
       color = "Engine Displacement") +
  theme_minimal()
```



6.2.

```
traffic <- read.csv("traffic.csv")
```

a.

```
num_observations <- nrow(traffic)
print(paste("Number of observations:", num_observations))
```

```
## [1] "Number of observations: 48120"
```

```
variables <- colnames(traffic)
print("Variables in the dataset:")
```

```
## [1] "Variables in the dataset:"
```

```
print(variables)
```

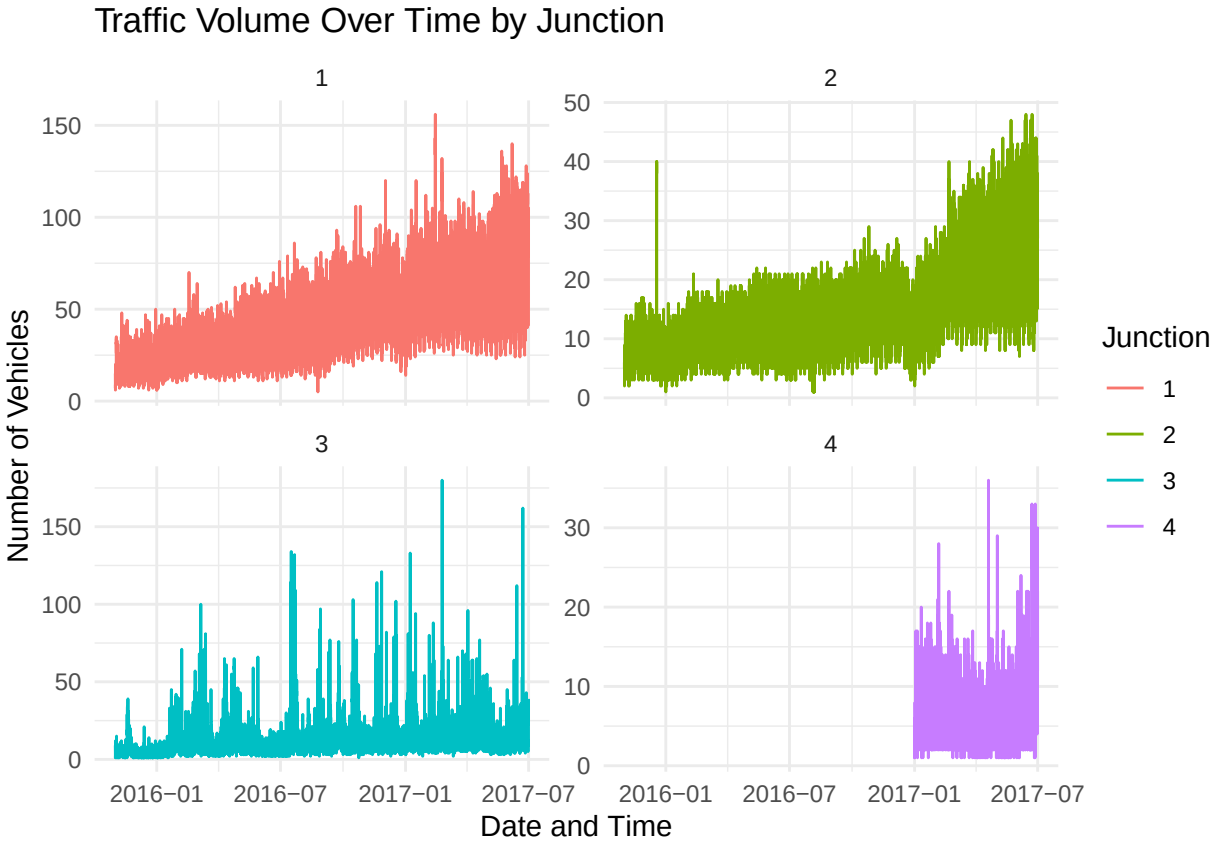
```
## [1] "DateTime" "Junction" "Vehicles" "ID"
```

b.

```
junction_subsets <- split(traffic, traffic$Junction)
```

```
library(ggplot2)
library(dplyr)


traffic$DateTime <- as.POSIXct(traffic$DateTime, format="%Y-%m-%d %H:%M:%S")

ggplot(traffic, aes(x = DateTime, y = Vehicles, color = factor(Junction))) +
```

```
  geom_line() +
  labs(title = "Traffic Volume Over Time by Junction",
       x = "Date and Time",
       y = "Number of Vehicles",
       color = "Junction") +
  theme_minimal() +
  facet_wrap(~ Junction, scales = "free_y")
```



7.

```
library(readxl)

alexa <- read_xlsx("alexa.xlsx")
```

a.

```
n <- nrow(alexa)
print(paste("Number of observations:", n))
```

```
## [1] "Number of observations: 3150"
```

```
v <- colnames(alexa)
print("Variables in the dataset:")
```

```
## [1] "Variables in the dataset:"
```

```
print(variables)
```

```
## [1] "DateTime" "Junction" "Vehicles" "ID"
```

b.

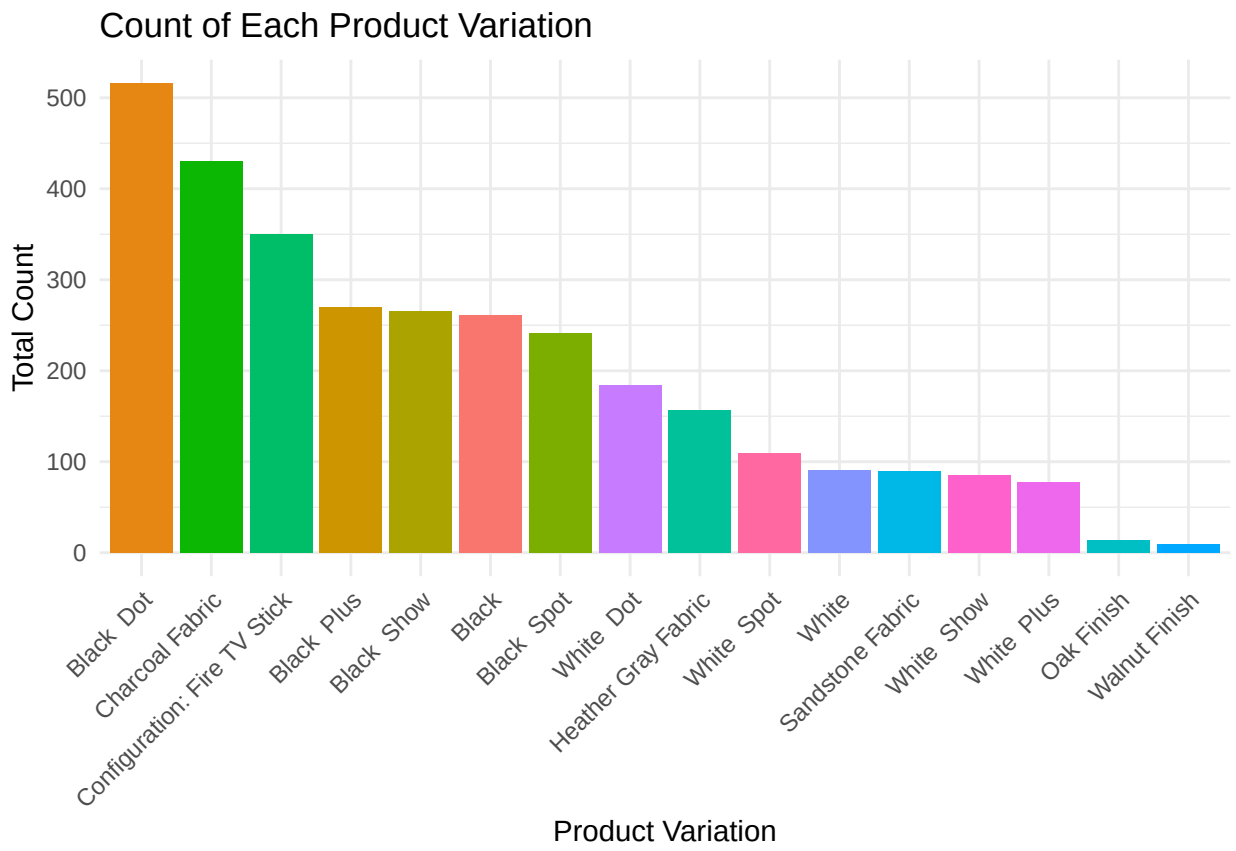
```
library(dplyr)


variation_counts <- alexa %>%
  group_by(variation) %>%
  summarise(total = n())

print(variation_counts)
```

```
## # 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
```

c. The plot presents the more popular choice and what the customers preffer more.

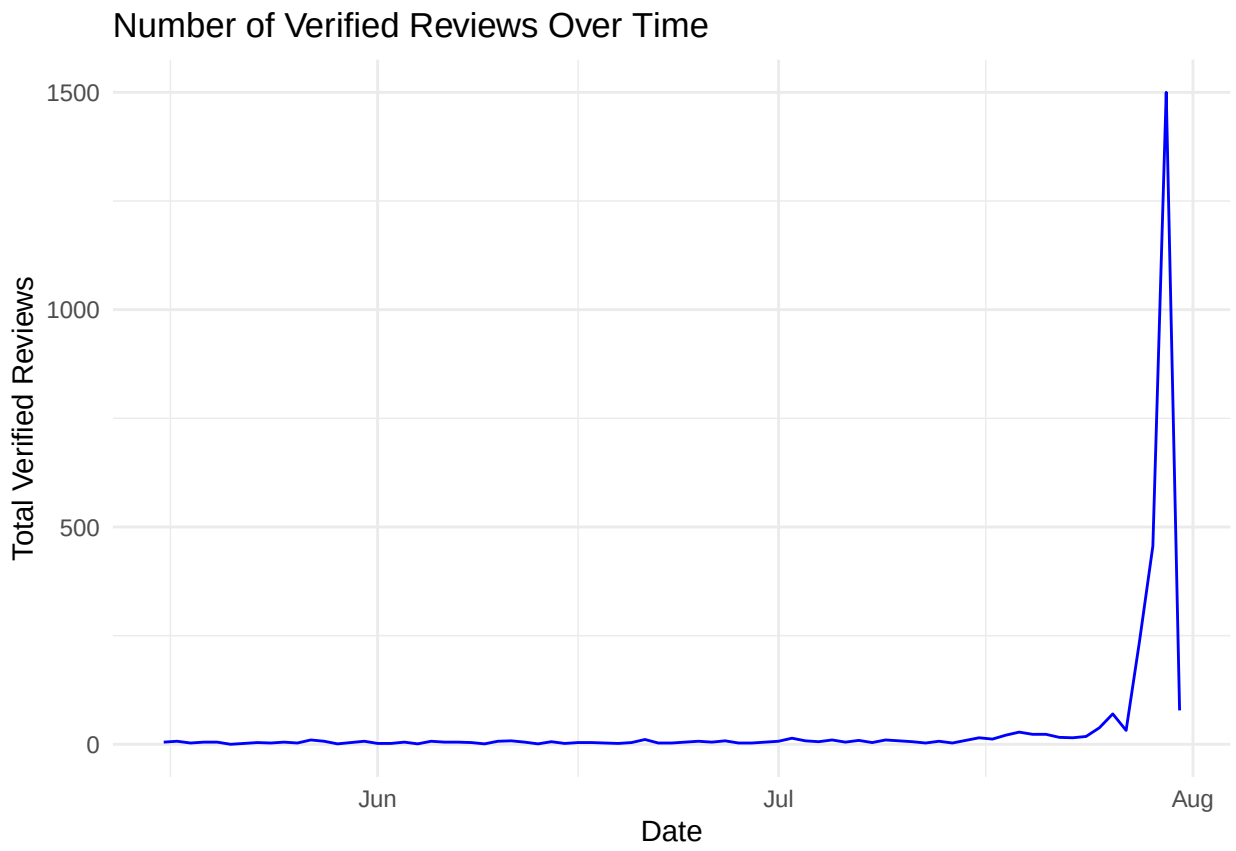
```
ggplot(variation_counts, aes(x = reorder(variation, -total), y = total, fill = variation)) +
  geom_bar(stat = "identity") +
  labs(title = "Count of Each Product Variation",
       x = "Product Variation",
       y = "Total Count") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  guides(fill = FALSE)
```

```
## Warning: The `<scale>` argument of `guides()` cannot be `FALSE`. Use "none" instead as
## of ggplot2 3.3.4.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```



d.

```
alexa$date <- as.Date(alexa$date)

daily_reviews <- alexa %>%
  group_by(date) %>%
  summarise(total_verified_reviews = sum(feedback))

ggplot(daily_reviews, aes(x = date, y = total_verified_reviews)) +
  geom_line(color = "blue") +
  labs(title = "Number of Verified Reviews Over Time",
       x = "Date",
       y = "Total Verified Reviews") +
  theme_minimal()
```



e.

```
library(dplyr)
library(ggplot2)

variation_ratings <- alexa %>%
  group_by(variation) %>%
  summarise(average_rating = mean(rating, na.rm = TRUE)) %>%

arrange(desc(average_rating))

variation_ratings
```

```
## # A tibble: 16 x 2
##    variation                    average_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
```

```
hv <- variation_ratings %>%
  slice(1)
hv
```

```
## # A tibble: 1 x 2
##   variation     average_rating
##   <chr>                  <dbl>
## 1 Walnut Finish           4.89
```

```
ggplot(variation_ratings, aes(x = reorder(variation, -average_rating), y = average_rating, fill = variat
  geom_bar(stat = "identity") +
  labs(title = "Average Rating by Product Variation",
       x = "Product Variation",
       y = "Average Rating") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  guides(fill = FALSE)
```