hw1

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R Markdown

```
cars=read.csv("mtcars.csv")
head(cars)
```

```
##               model  mpg cyl disp  hp drat    wt  qsec vs am gear carb
## 1         Mazda RX4 21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## 2     Mazda RX4 Wag 21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## 3        Datsun 710 22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## 4    Hornet 4 Drive 21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## 5 Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## 6           Valiant 18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

Q1

```
v1 = mean(cars$mpg)
v2 = mean(cars$cyl)
v3 = mean(cars$disp)
v4 = mean(cars$hp)
v5 = mean(cars$drat)
v6 = mean(cars$wt)
v7 = mean(cars$qsec)
v8 = mean(cars$vs)
v9 = mean(cars$am)
v10 = mean(cars$gear)
v11 = mean(cars$carb)
tab <- matrix(c(v1, v2, v3, v4, v5, v6, v7, v8, v9, v10, v11), ncol=11)
colnames(tab) <- c("mpg", "cyl", "disp", "hp", "drat", "wt", "qsec", "vs", "am", "gear", "carb")
rownames(tab) <- c("mean")
library(knitr)
kable(tab)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
mean	20.09062	6.1875	230.7219	146.6875	3.596563	3.21725	17.84875	0.4375	0.40625	3.6875	2.8125

Q2

```
df = as.data.frame(cars)
df <- df[ , -which(names(df) %in% c("model"))]
result_1 = cov(df)
result_2 = cor(df)
result_1
```

```
##              mpg         cyl        disp          hp         drat          wt
## mpg    36.324103  -9.1723790  -633.09721 -320.732056   2.19506351  -5.1166847
## cyl    -9.172379   3.1895161   199.66028  101.931452  -0.66836694   1.3673710
## disp -633.097208 199.6602823 15360.79983 6721.158669 -47.06401915 107.6842040
## hp   -320.732056 101.9314516  6721.15867 4700.866935 -16.45110887  44.1926613
## drat    2.195064  -0.6683669   -47.06402  -16.451109   0.28588135  -0.3727207
## wt     -5.116685   1.3673710   107.68420   44.192661  -0.37272073   0.9573790
## qsec    4.509149  -1.8868548   -96.05168  -86.770081   0.08714073  -0.3054816
## vs      2.017137  -0.7298387   -44.37762  -24.987903   0.11864919  -0.2736613
## am      1.803931  -0.4657258   -36.56401   -8.320565   0.19015121  -0.3381048
## gear    2.135685  -0.6491935   -50.80262   -6.358871   0.27598790  -0.4210806
## carb   -5.363105   1.5201613    79.06875   83.036290  -0.07840726   0.6757903
##              qsec           vs           am        gear        carb
## mpg    4.50914919   2.01713710   1.80393145   2.1356855 -5.36310484
## cyl   -1.88685484  -0.72983871  -0.46572581  -0.6491935  1.52016129
## disp -96.05168145 -44.37762097 -36.56401210 -50.8026210 79.06875000
## hp   -86.77008065 -24.98790323  -8.32056452  -6.3588710 83.03629032
## drat   0.08714073   0.11864919   0.19015121   0.2759879 -0.07840726
## wt    -0.30548161  -0.27366129  -0.33810484  -0.4210806  0.67579032
## qsec   3.19316613   0.67056452  -0.20495968  -0.2804032 -1.89411290
## vs     0.67056452   0.25403226   0.04233871   0.0766129 -0.46370968
## am    -0.20495968   0.04233871   0.24899194   0.2923387  0.04637097
## gear  -0.28040323   0.07661290   0.29233871   0.5443548  0.32661290
## carb  -1.89411290  -0.46370968   0.04637097   0.3266129  2.60887097
```

```
result_2
```

```
##             mpg        cyl       disp         hp        drat         wt
## mpg   1.0000000 -0.8521620 -0.8475514 -0.7761684  0.68117191 -0.8676594
## cyl  -0.8521620  1.0000000  0.9020329  0.8324475 -0.69993811  0.7824958
## disp -0.8475514  0.9020329  1.0000000  0.7909486 -0.71021393  0.8879799
## hp   -0.7761684  0.8324475  0.7909486  1.0000000 -0.44875912  0.6587479
## drat  0.6811719 -0.6999381 -0.7102139 -0.4487591  1.00000000 -0.7124406
## wt   -0.8676594  0.7824958  0.8879799  0.6587479 -0.71244065  1.0000000
## qsec  0.4186840 -0.5912421 -0.4336979 -0.7082234  0.09120476 -0.1747159
## vs    0.6640389 -0.8108118 -0.7104159 -0.7230967  0.44027846 -0.5549157
## am    0.5998324 -0.5226070 -0.5912270 -0.2432043  0.71271113 -0.6924953
## gear  0.4802848 -0.4926866 -0.5555692 -0.1257043  0.69961013 -0.5832870
## carb -0.5509251  0.5269883  0.3949769  0.7498125 -0.09078980  0.4276059
##             qsec         vs          am       gear        carb
## mpg   0.41868403  0.6640389  0.59983243  0.4802848 -0.55092507
## cyl  -0.59124207 -0.8108118 -0.52260705 -0.4926866  0.52698829
## disp -0.43369788 -0.7104159 -0.59122704 -0.5555692  0.39497686
## hp   -0.70822339 -0.7230967 -0.24320426 -0.1257043  0.74981247
```

```
## drat  0.09120476  0.4402785  0.71271113  0.6996101 -0.09078980
## wt   -0.17471588 -0.5549157 -0.69249526 -0.5832870  0.42760594
## qsec  1.00000000  0.7445354 -0.22986086 -0.2126822 -0.65624923
## vs    0.74453544  1.0000000  0.16834512  0.2060233 -0.56960714
## am   -0.22986086  0.1683451  1.00000000  0.7940588  0.05753435
## gear -0.21268223  0.2060233  0.79405876  1.0000000  0.27407284
## carb -0.65624923 -0.5696071  0.05753435  0.2740728  1.00000000
```

Explanation:

Based on the variance-covariance matrix, it can be interpreted that the diagonal is the variance of the variable. A positive covariance means that two variables increase or decrease at the same time. For example, the covariance of disp and cyl is 199.66028 which means when disp increases cyl tends to increase too. Some other pairs of variable that have a positive covariance are hp and cyl, qsec and mpg, and drat and vs. A negative covariance means that two variables means that when one of the variables increases the other one decreases. Some examples are disp and mpg whose covariance is -633.09721, drat and cyl whose covariance is -0.69993811, and hp and qsec whose covariance is -0.70822339. The correlation matrix tells us the correlation between two variables. A large and positive correlation means that two variables have a strong correlation and that they increase simultaneously. Examples for strong positive correlations are drat and mpg, disp and cyl, carb and hp. A small correlation that is close to 0 means that two variables are unlikely to be correlated. Pairs of variables that are not correlated are am and hp, qsec and wt, gear and vs. Negative and large correlations indicate that two variables change oppositely. While one variable decreases, the other increases. Examples of pairs of varibles that have this correlation are drat and wt, wt and mpg, and vs and disp.

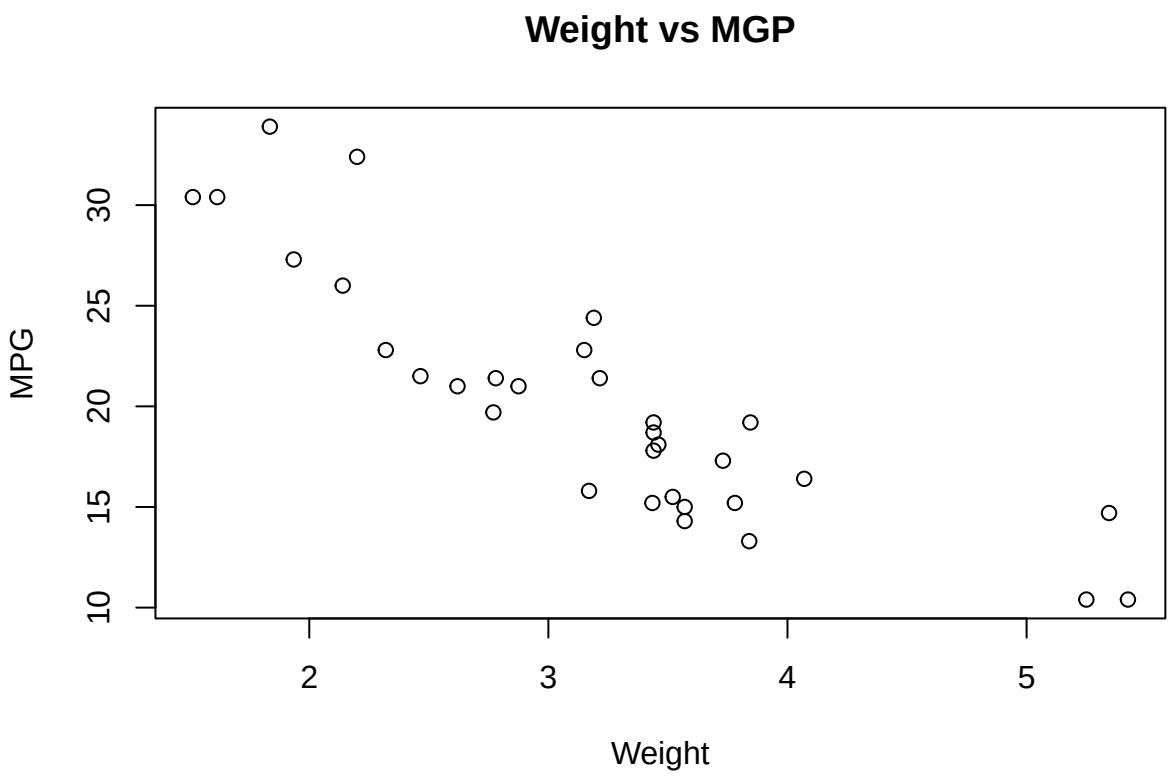
Q3

```
d = read.csv("mtcars.csv")
d
```

```
##                  model  mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## 1            Mazda RX4 21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
## 2        Mazda RX4 Wag 21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
## 3           Datsun 710 22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## 4       Hornet 4 Drive 21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
## 5    Hornet Sportabout 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
## 6              Valiant 18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
## 7           Duster 360 14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
## 8            Merc 240D 24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
## 9             Merc 230 22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
## 10            Merc 280 19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
## 11           Merc 280C 17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
## 12          Merc 450SE 16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
## 13          Merc 450SL 17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
## 14         Merc 450SLC 15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
## 15  Cadillac Fleetwood 10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
## 16 Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
## 17   Chrysler Imperial 14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
## 18            Fiat 128 32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
## 19         Honda Civic 30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
```

```
## 20      Toyota Corolla 33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
## 21       Toyota Corona 21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## 22    Dodge Challenger 15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
## 23         AMC Javelin 15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
## 24          Camaro Z28 13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
## 25    Pontiac Firebird 19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
## 26           Fiat X1-9 27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## 27       Porsche 914-2 26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## 28        Lotus Europa 30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
## 29      Ford Pantera L 15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
## 30        Ferrari Dino 19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
## 31       Maserati Bora 15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
## 32          Volvo 142E 21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

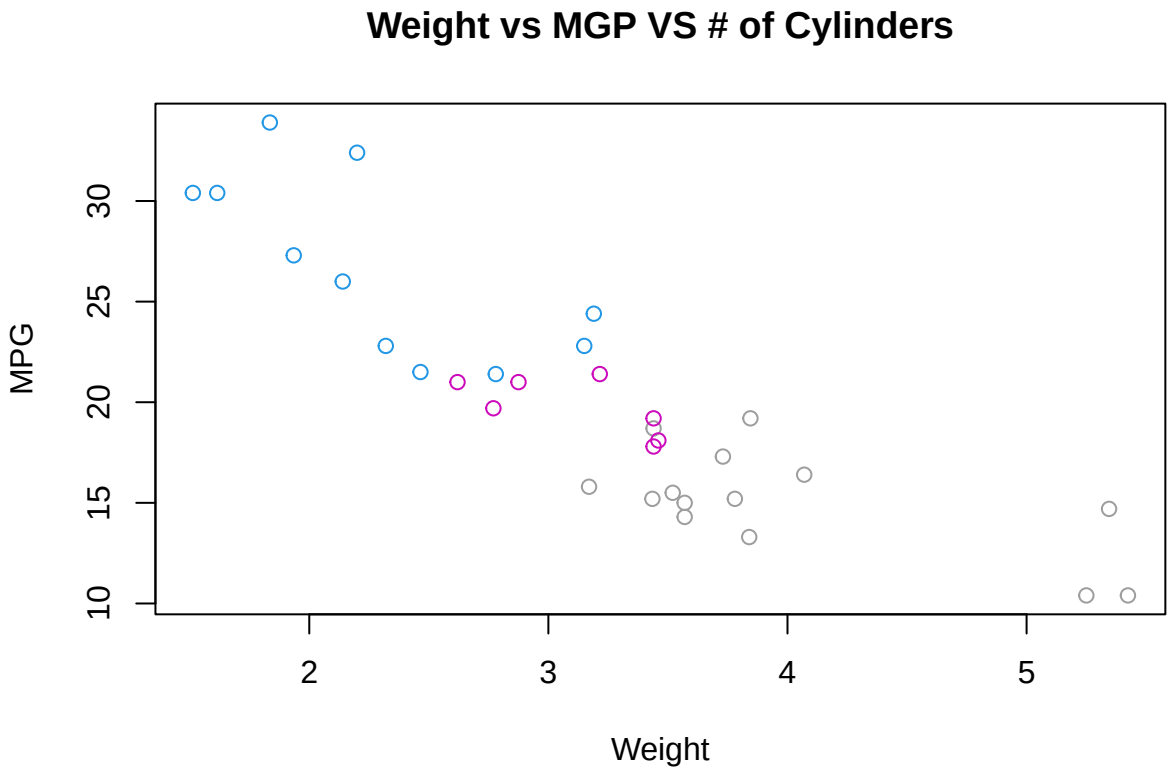
```
plot(x = d$wt,
     y = d$mpg,
     xlab = "Weight",
     ylab = "MPG",
     main = "Weight vs MGP")
```



Q4

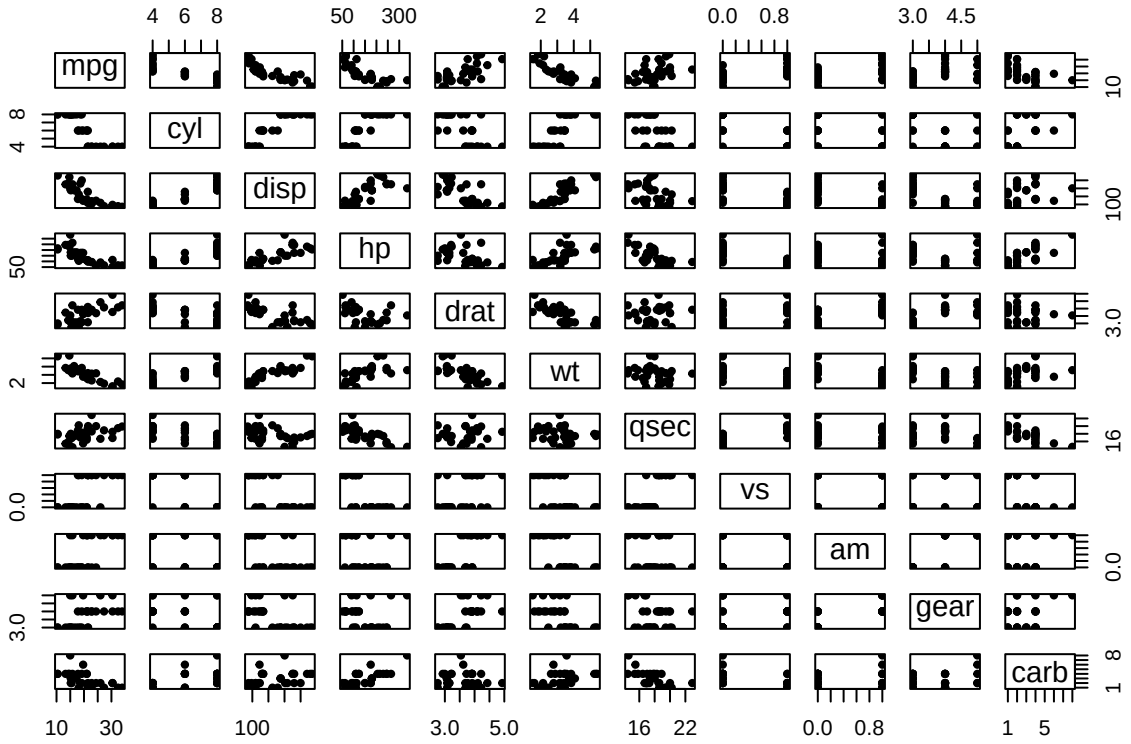
Blue is 4 cylinder, Purple is 6 cylinder, and Gray is 8 cylinder

```r
plot(x = d$wt,
     y = d$mpg,
     col = d$cyl,
     xlab = "Weight",
     ylab = "MPG",
     main = "Weight vs MGP VS # of Cylinders")
```



Q5

```r
cars_num=subset(cars,select=-c(model))
pairs(cars_num, pch=20)
```



Q6

There is a relationship between wt and mpg and it is subject to the number of cylinders. As shown in the colored scatter plot, vehicles that weigh less and have 4 cylinders have the highest MPG. The second group is the 6 cylinder vehicles with medium weight and they have medium MPG. The last group is the heavy vehicles with the most cylinders and they have the lowest MPG.

Q7

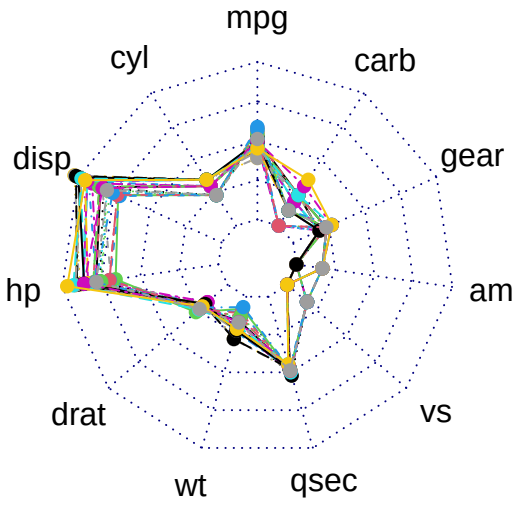
```
library(fmsb)
max_min <- data.frame(mpg = c(6, 0), cyl = c(6, 0), disp = c(6, 0), hp = c(6, 0), drat = c(6, 0), wt = c
rownames(max_min) <- c("max", "min")
df=data.frame(cars_num)
df <- log(df[ , -which(names(df) %in% c("am","vs"))])
df$vs <- cars_num$vs
df$am <- cars_num$am
df <- rbind(max_min, df)
df
```

```
##          mpg      cyl     disp       hp     drat        wt     qsec vs am
## max 6.000000 6.000000 6.000000 6.000000 6.000000 6.0000000 6.000000  6  6
## min 0.000000 0.000000 0.000000 0.000000 0.000000 0.0000000 0.000000  0  0
```

```
## 1   3.044522 1.791759 5.075174 4.700480 1.360977 0.9631743 2.800933  0  1
## 2   3.044522 1.791759 5.075174 4.700480 1.360977 1.0560527 2.834389  0  1
## 3   3.126761 1.386294 4.682131 4.532599 1.348073 0.8415672 2.923699  1  1
## 4   3.063391 1.791759 5.552960 4.700480 1.124930 1.1678274 2.967333  1  0
## 5   2.928524 2.079442 5.886104 5.164786 1.147402 1.2354715 2.834389  0  0
## 6   2.895912 1.791759 5.416100 4.653960 1.015231 1.2412686 3.006672  1  0
## 7   2.660260 2.079442 5.886104 5.501258 1.166271 1.2725656 2.762538  0  0
## 8   3.194583 1.386294 4.988390 4.127134 1.305626 1.1600209 2.995732  1  0
## 9   3.126761 1.386294 4.947340 4.553877 1.366092 1.1474025 3.131137  1  0
## 10  2.954910 1.791759 5.121580 4.812184 1.366092 1.2354715 2.906901  1  0
## 11  2.879198 1.791759 5.121580 4.812184 1.366092 1.2354715 2.939162  1  0
## 12  2.797281 2.079442 5.619676 5.192957 1.121678 1.4036430 2.856470  0  0
## 13  2.850707 2.079442 5.619676 5.192957 1.121678 1.3164082 2.867899  0  0
## 14  2.721295 2.079442 5.619676 5.192957 1.121678 1.3297240 2.890372  0  0
## 15  2.341806 2.079442 6.156979 5.323010 1.075002 1.6582281 2.889260  0  0
## 16  2.341806 2.079442 6.131226 5.370638 1.098612 1.6908336 2.880321  0  0
## 17  2.687847 2.079442 6.086775 5.438079 1.172482 1.6761615 2.857619  0  0
## 18  3.478158 1.386294 4.365643 4.189655 1.406097 0.7884574 2.968875  1  1
## 19  3.414443 1.386294 4.326778 3.951244 1.595339 0.4793350 2.918851  1  1
## 20  3.523415 1.386294 4.264087 4.174387 1.439835 0.6070445 2.990720  1  1
## 21  3.068053 1.386294 4.788325 4.574711 1.308333 0.9021918 2.996232  1  0
## 22  2.740840 2.079442 5.762051 5.010635 1.015231 1.2584610 2.825537  0  0
## 23  2.721295 2.079442 5.717028 5.010635 1.147402 1.2340169 2.850707  0  0
## 24  2.587764 2.079442 5.857933 5.501258 1.316408 1.3454724 2.735017  0  0
## 25  2.954910 2.079442 5.991465 5.164786 1.124930 1.3467736 2.836150  0  0
## 26  3.306887 1.386294 4.369448 4.189655 1.406097 0.6601073 2.939162  1  1
## 27  3.258097 1.386294 4.789989 4.510860 1.488400 0.7608058 2.815409  0  1
## 28  3.414443 1.386294 4.554929 4.727388 1.327075 0.4140944 2.827314  1  1
## 29  2.760010 2.079442 5.860786 5.575949 1.439835 1.1537316 2.674149  0  1
## 30  2.980619 1.791759 4.976734 5.164786 1.286474 1.0188473 2.740840  0  1
## 31  2.708050 2.079442 5.707110 5.814131 1.264127 1.2725656 2.681022  0  1
## 32  3.063391 1.386294 4.795791 4.691348 1.413423 1.0224509 2.923162  1  1
##         gear      carb
## max 6.000000 6.0000000
## min 0.000000 0.0000000
## 1   1.386294 1.3862944
## 2   1.386294 1.3862944
## 3   1.386294 0.0000000
## 4   1.098612 0.0000000
## 5   1.098612 0.6931472
## 6   1.098612 0.0000000
## 7   1.098612 1.3862944
## 8   1.386294 0.6931472
## 9   1.386294 0.6931472
## 10  1.386294 1.3862944
## 11  1.386294 1.3862944
## 12  1.098612 1.0986123
## 13  1.098612 1.0986123
## 14  1.098612 1.0986123
## 15  1.098612 1.3862944
## 16  1.098612 1.3862944
## 17  1.098612 1.3862944
## 18  1.386294 0.0000000
## 19  1.386294 0.6931472
```

```
## 20  1.386294 0.0000000
## 21  1.098612 0.0000000
## 22  1.098612 0.6931472
## 23  1.098612 0.6931472
## 24  1.098612 1.3862944
## 25  1.098612 0.6931472
## 26  1.386294 0.0000000
## 27  1.609438 0.6931472
## 28  1.609438 0.6931472
## 29  1.609438 1.3862944
## 30  1.609438 1.7917595
## 31  1.609438 2.0794415
## 32  1.386294 0.6931472
```

```
radarchart(df)
```



Explanation: I can't tell from the chart since there are so many cars in the chart and they are pretty close on the chart.