IST687

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Homework 2 - Writing functions and doing some initial data analysis

Assignment Due: 7/20/2021

Submitted: 7/19/2021

Explore the mtcars data set (which is already included in R). Copy the mtcars data set into a new variable (called it myCars), so that if you mess up, you can start again very easily (by copying mtcars into myCars again).

```
myCars<-data.frame(mtcars)
```

Step 1: What is the hp (hp stands for "horse power")

1) What is the highest hp?

```
 max(myCars$hp)
```

```
## [1] 335
```

2) Which car has the highest hp?

```
rownames(myCars)[which.max(myCars$hp)]
```

```
## [1] "Maserati Bora"
```

Step 2: Explore mpg (mpg stands for "miles per gallon")

3) What is the highest mpg?

```
max(myCars$mpg)
```

```
## [1] 33.9
```

4) Which car has the highest mpg?

```
rownames(myCars)[which.max(myCars$mpg)]
```

```
## [1] "Toyota Corolla"
```

5) Create a sorted dataframe, based on mpg

Below is sorted by ascending MPG.

```
myCars[order(myCars$mpg),]
```

```
##                      mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
## Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
## Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
## Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
## Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
## Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
## Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
## AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
## Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
## Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
## Merc 450SE          16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
## Merc 450SL          17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
## Merc 280C           17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
## Valiant             18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
## Hornet Sportabout   18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
## Merc 280            19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
## Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
## Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
## Mazda RX4           21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag       21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
## Hornet 4 Drive      21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
## Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
## Toyota Corona       21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## Datsun 710          22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## Merc 230            22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
## Merc 240D           24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
## Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## Honda Civic         30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
## Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
## Fiat 128            32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
## Toyota Corolla      33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
```

Step 3: Which car has the "best" combination of mpg and hp?

6) What logic did you use?

There are multiple ways arrive at a conclusion of which vehicle offers the "best" combination of mpg and hp.

First, we can find the vehicle which produces the greatest marginal mileage per unit of horsepower. I did this by determining each vehicle's ratio of MPG/HP and adding a new column to the data frame. This informs us of the marginal increase in MPG per unit of horsepower.

The second approach is to determine the relationship between 1 unit of horsepower per MPG. I explore this by determining each vehicle's ratio of HP/MPG and adding to the data frame.

```
#Instantiate Two new Vectors to Contain Ratio's of MPG/HP & HP/MPG
mpgToHorsePowerRat <- c()
horsePowerToMpgRat <- c()

#Iterate through 'myCars' calculate the MPG/HP & HP/MPG Ratios
for(i in 1:nrow(myCars)){
  mpgHpPowerratio <- (myCars$mpg[i]/myCars$hp[i])
```

```
  hpToMpgPowerRatio <- (myCars$hp[i]/myCars$mpg[i])
  #Add created ratios to vectors, organized by index
  mpgToHorsePowerRat[i]<- mpgHpPowerratio
  horsePowerToMpgRat[i]<- hpToMpgPowerRatio

}

#Add new column to 'myCars' from vectors to containing ratio's of MPG/HP & HP/MPG
myCars <- cbind(myCars, mpgToHorsePowerRat)
myCars <- cbind(myCars, horsePowerToMpgRat)
```

Each of these approaches identifies a different vehicle. In this instance, we would need to know more information from the audience of their requirements in order to decide between the two vehicles, which leads us to another method to identify the vehicle which has the most optimal relationship between HP and MPG.

```
rownames(myCars)[which.max(myCars$mpgToHorsePowerRat)]
```

```
## [1] "Honda Civic"
```

```
rownames(myCars)[which.max(myCars$horsePowerToMpgRat)]
```

```
## [1] "Maserati Bora"
```

If we are unable to gather information on the data audience's requirements, there is a third approach that will give us a most generalized answer. First we normalize all values contained within the HP and MPG columns. This allows us to view the data through the lens of a common scale. Working with this common scale (mean MPG and mean HP as zero) we can combine these values to create an overall "score", then all we need to find is the maximum combined normalized value (below).

```
#Here we normalize the data, so that the mean is 0
#with a standard deviation of 1. I do this to standardize the data

nMpg <- scale(myCars$mpg)
nHp <- scale(myCars$hp)

#Add new columns to 'myCars' from vectors to containing ratio's
#of MPG/HP, HP/MPG, and normalized MPG & HP
myCars <- cbind(myCars, mpgToHorsePowerRat, horsePowerToMpgRat, nMpg,nHp )

#Create a new column of the combination of Normalized MPG & Normalized HP
nMpgHp <-(nMpg + nHp )
myCars <- cbind(myCars, nMpgHp)
```

7) Which car?

When we find the maximum normalized combined value of horse power and miles per gallon, we arrive at the conclusion that the most optimal vehicle is the Maserati Bora.

```
myCars[which.max(myCars$nMpgHp),]
```

```
##                mpg cyl disp  hp drat   wt qsec vs am gear carb
## Maserati Bora  15   8  301 335 3.54 3.57 14.6  0  1    5    8
##                mpgToHorsePowerRat horsePowerToMpgRat mpgToHorsePowerRat
## Maserati Bora          0.04477612           22.33333         0.04477612
##                horsePowerToMpgRat       nMpg      nHp   nMpgHp
## Maserati Bora           22.33333 -0.8446439 2.746567 1.901923
```

Reference: All vehicles sorted by descending combined normalized MPG and normalized HP.

```
myCars[order(-myCars$nMpgHp),]
```

```
##                      mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
## Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
## Toyota Corolla      33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
## Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
## Fiat 128            32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
## Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
## Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
## Honda Civic         30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
## Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
## Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
## Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
## Hornet Sportabout   18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
## Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## Merc 450SL          17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
## Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## Merc 450SE          16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
## Merc 230            22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
## Hornet 4 Drive      21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
## Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
## Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
## Datsun 710          22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## Mazda RX4           21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag       21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
## Toyota Corona       21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## Merc 280            19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
## Merc 240D           24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
## Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
## Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
## Merc 280C           17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
## Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
## AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
## Valiant             18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
##                     mpgToHorsePowerRat horsePowerToMpgRat mpgToHorsePowerRat
## Maserati Bora              0.04477612          22.333333         0.04477612
## Lotus Europa               0.26902655           3.717105         0.26902655
## Toyota Corolla             0.52153846           1.917404         0.52153846
## Ford Pantera L             0.05984848          16.708861         0.05984848
## Fiat 128                   0.49090909           2.037037         0.49090909
## Duster 360                 0.05836735          17.132867         0.05836735
```

```
## Ferrari Dino               0.11257143          8.883249         0.11257143
## Honda Civic                0.58461538          1.710526         0.58461538
## Chrysler Imperial          0.06391304         15.646259         0.06391304
## Camaro Z28                 0.05428571         18.421053         0.05428571
## Pontiac Firebird           0.10971429          9.114583         0.10971429
## Hornet Sportabout          0.10685714          9.358289         0.10685714
## Porsche 914-2              0.28571429          3.500000         0.28571429
## Merc 450SL                 0.09611111         10.404624         0.09611111
## Fiat X1-9                  0.41363636          2.417582         0.41363636
## Merc 450SE                 0.09111111         10.975610         0.09111111
## Merc 230                   0.24000000          4.166667         0.24000000
## Hornet 4 Drive             0.19454545          5.140187         0.19454545
## Merc 450SLC                0.08444444         11.842105         0.08444444
## Volvo 142E                 0.19633028          5.093458         0.19633028
## Datsun 710                 0.24516129          4.078947         0.24516129
## Mazda RX4                  0.19090909          5.238095         0.19090909
## Mazda RX4 Wag              0.19090909          5.238095         0.19090909
## Toyota Corona              0.22164948          4.511628         0.22164948
## Merc 280                   0.15609756          6.406250         0.15609756
## Merc 240D                  0.39354839          2.540984         0.39354839
## Lincoln Continental        0.04837209         20.673077         0.04837209
## Dodge Challenger           0.10333333          9.677419         0.10333333
## Merc 280C                  0.14471545          6.910112         0.14471545
## Cadillac Fleetwood         0.05073171         19.711538         0.05073171
## AMC Javelin                0.10133333          9.868421         0.10133333
## Valiant                    0.17238095          5.801105         0.17238095
##                      horsePowerToMpgRat        nMpg          nHp       nMpgHp
## Maserati Bora              22.333333 -0.84464392  2.74656682  1.90192291
## Lotus Europa                3.717105  1.71054652 -0.49133738  1.21920914
## Toyota Corolla              1.917404  2.29127162 -1.19142477  1.09984684
## Ford Pantera L             16.708861 -0.71190675  1.71102089  0.99911414
## Fiat 128                    2.037037  2.04238943 -1.17683962  0.86554981
## Duster 360                 17.132867 -0.96078893  1.43390296  0.47311402
## Ferrari Dino                8.883249 -0.06481307  0.41294217  0.34812911
## Honda Civic                 1.710526  1.71054652 -1.38103178  0.32951474
## Chrysler Imperial          15.646259 -0.89442035  1.21512565  0.32070530
## Camaro Z28                 18.421053 -1.12671039  1.43390296  0.30719257
## Pontiac Firebird            9.114583 -0.14777380  0.41294217  0.26516838
## Hornet Sportabout           9.358289 -0.23073453  0.41294217  0.18220765
## Porsche 914-2               3.500000  0.98049211 -0.81221077  0.16828134
## Merc 450SL                 10.404624 -0.46302456  0.48586794  0.02284338
## Fiat X1-9                   2.417582  1.19619000 -1.17683962  0.01935038
## Merc 450SE                 10.975610 -0.61235388  0.48586794 -0.12648593
## Merc 230                    4.166667  0.44954345 -0.75387015 -0.30432670
## Hornet 4 Drive              5.140187  0.21725341 -0.53509284 -0.31783943
## Merc 450SLC                11.842105 -0.81145962  0.48586794 -0.32559168
## Volvo 142E                  5.093458  0.21725341 -0.54967799 -0.33242459
## Datsun 710                  4.078947  0.44954345 -0.78304046 -0.33349701
## Mazda RX4                   5.238095  0.15088482 -0.53509284 -0.38420802
## Mazda RX4 Wag               5.238095  0.15088482 -0.53509284 -0.38420802
## Toyota Corona               4.511628  0.23384555 -0.72469984 -0.49085429
## Merc 280                    6.406250 -0.14777380 -0.34548584 -0.49325963
## Merc 240D                   2.540984  0.71501778 -1.23518023 -0.52016246
## Lincoln Continental        20.673077 -1.60788262  0.99634834 -0.61153428
```

```
## Dodge Challenger             9.677419 -0.76168319  0.04831332 -0.71336986
## Merc 280C                    6.910112 -0.38006384 -0.34548584 -0.72554967
## Cadillac Fleetwood          19.711538 -1.60788262  0.85049680 -0.75738582
## AMC Javelin                  9.868421 -0.81145962  0.04831332 -0.76314630
## Valiant                      5.801105 -0.33028740 -0.60801861 -0.93830601
```