Homework 1

2025-09-01

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practice of basic R commands:

```
3 + 2 #5
```

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

```
6 - 6 #0
```

```
## [1] 0
```

```
5 * 2 #10
```

```
## [1] 10
```

```
4 / 2 #2
```

```
## [1] 2
```

```
4^2 #16
```

```
## [1] 16
```

```
4 %% 3 #1
```

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

```
13 %/% 4 #3
```

```
## [1] 3
```

```
3 == 3 # True
```

```
## [1] TRUE
```

```
4 != 1 # True
```

```
## [1] TRUE
```

```
8 > 9 #False
```

```
## [1] FALSE
```

```
4 < 6 #True
```

```
## [1] TRUE
```

```
(3 == 3) & (4 == 4) #True
```

```
## [1] TRUE
```

```
(4 != 3) | (5 < 2) #True
```

```
## [1] TRUE
```

```
!(3 > 2) #False
```

```
## [1] FALSE
```

```
set1 <- c(1, 2, 3, 4, 5, 6)
sum(set1)      # Sum: 21
```

```
## [1] 21
```

```
mean(set1)     # Mean: 3.5
```

```
## [1] 3.5
```

```
median(set1)   # Median: 3.5
```

```
## [1] 3.5
```

```
sd(set1)       # Standard Deviation: 1.871
```

```
## [1] 1.870829
```

```
min(set1)      # Minimum: 1
```

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

```
max(set1)      # Maximum: 6
```

```
## [1] 6
```

```
range(set1)    # Range: 1 6
```

```
## [1] 1 6
```

```
length(set1)   # Length: 6
```

```
## [1] 6
```

```
vec <- c(1, 2, 3, 4, 5, 6) # Vector
vec[2]    # Second element
```

```
## [1] 2
```

```
vec[1:4]  # First four elements
```

```
## [1] 1 2 3 4
```

```
vec + 3       # Adds 3 to each element
```

```
## [1] 4 5 6 7 8 9
```

```
vec * 3       # Multiplies each element by 3
```

```
## [1]  3  6  9 12 15 18
```

```
sum(vec)      # Sum of elements
```

```
## [1] 21
```

```
mean(vec)     # Mean of elements
```

```
## [1] 3.5
```

```
mat <- matrix(1:9, nrow=3, ncol=3) # Matrix
mat[3, 1]     # Element in third row, first column
```

```
## [1] 3
```

```r
mat[, 2]      # Second column
```

```
## [1] 4 5 6
```

```r
mat[3, ]      # Third row
```

```
## [1] 3 6 9
```

```r
mat + 3       # Add 3 to each element
```

```
##      [,1] [,2] [,3]
## [1,]    4    7   10
## [2,]    5    8   11
## [3,]    6    9   12
```

```r
mat * 3       # Multiply each element by 3
```

```
##      [,1] [,2] [,3]
## [1,]    3   12   21
## [2,]    6   15   24
## [3,]    9   18   27
```

```r
mat %*% mat   # Matrix multiplication
```

```
##      [,1] [,2] [,3]
## [1,]   30   66  102
## [2,]   36   81  126
## [3,]   42   96  150
```

```r
df <- data.frame(
  Type = c("A", "B", "C"),
  Length = c(25, 30, 35),
  Width = c(5.5, 6.0, 5.8)
)
df$Type     # Access by column name
```

```
## [1] "A" "B" "C"
```

```r
df[, 3]     # Access by column position (third column)
```

```
## [1] 5.5 6.0 5.8
```

```r
df$Weight <- c(130, 150, 160) # Adding another column
df$Length <- NULL # Removing a column

my_list <- list(
  Type = "A",
  Length = 25,
  Age = c(85, 90, 95)
)
my_list$Type         # Access by name
```

```
## [1] "A"
```

```r
my_list[[2]]         # Access by position
```

```
## [1] 25
```

```r
my_list$Age[2]    # Accessing elements within a vector in a list
```

```
## [1] 90
```

tidyverse:

```
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.2     v tibble    3.3.0
## v lubridate 1.9.4     v tidyr     1.3.1
## v purrr     1.1.0
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

data.table:

```
mtcars
```

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

```
View(mtcars)
mtcars[, 1] # Returns a tibble
```

```
##  [1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3 15.2 10.4
```

```
## [16] 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3 26.0 30.4 15.8 19.7
## [31] 15.0 21.4
```

```
as.data.frame(mtcars)[, 1] # Returns a data frame
```

```
##  [1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3 15.2 10.4
## [16] 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3 26.0 30.4 15.8 19.7
## [31] 15.0 21.4
```

dplyr:

```
head(mtcars) # First six rows of data
```

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

```
str(mtcars) # Shows size of the data set and the types of variables in each column
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

```
summary(mtcars) # Summarizes the values for each variable
```

```
##       mpg             cyl             disp             hp       
##  Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0  
##  1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5  
##  Median :19.20   Median :6.000   Median :196.3   Median :123.0  
##  Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7  
##  3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0  
##  Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0  
##       drat             wt             qsec             vs        
##  Min.   :2.760   Min.   :1.513   Min.   :14.50   Min.   :0.0000  
##  1st Qu.:3.080   1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000  
##  Median :3.695   Median :3.325   Median :17.71   Median :0.0000  
##  Mean   :3.597   Mean   :3.217   Mean   :17.85   Mean   :0.4375  
##  3rd Qu.:3.920   3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000  
##  Max.   :4.930   Max.   :5.424   Max.   :22.90   Max.   :1.0000  
##        am              gear            carb      
##  Min.   :0.0000   Min.   :3.000   Min.   :1.000  
##  1st Qu.:0.0000   1st Qu.:3.000   1st Qu.:2.000  
##  Median :0.0000   Median :4.000   Median :2.000  
##  Mean   :0.4062   Mean   :3.688   Mean   :2.812
```

```
##  3rd Qu.:1.0000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :1.0000   Max.   :5.000   Max.   :8.000
```

```r
names(mtcars) # Lists all column names
```

```
##  [1] "mpg"  "cyl"  "disp" "hp"   "drat" "wt"   "qsec" "vs"   "am"   "gear"
## [11] "carb"
```

```r
select(mtcars, mpg, wt) # Selects only mpg and wt columns
```

```
##                      mpg    wt
## Mazda RX4           21.0 2.620
## Mazda RX4 Wag       21.0 2.875
## Datsun 710          22.8 2.320
## Hornet 4 Drive      21.4 3.215
## Hornet Sportabout   18.7 3.440
## Valiant             18.1 3.460
## Duster 360          14.3 3.570
## Merc 240D           24.4 3.190
## Merc 230            22.8 3.150
## Merc 280            19.2 3.440
## Merc 280C           17.8 3.440
## Merc 450SE          16.4 4.070
## Merc 450SL          17.3 3.730
## Merc 450SLC         15.2 3.780
## Cadillac Fleetwood  10.4 5.250
## Lincoln Continental 10.4 5.424
## Chrysler Imperial   14.7 5.345
## Fiat 128            32.4 2.200
## Honda Civic         30.4 1.615
## Toyota Corolla      33.9 1.835
## Toyota Corona       21.5 2.465
## Dodge Challenger    15.5 3.520
## AMC Javelin         15.2 3.435
## Camaro Z28          13.3 3.840
## Pontiac Firebird    19.2 3.845
## Fiat X1-9           27.3 1.935
## Porsche 914-2       26.0 2.140
## Lotus Europa        30.4 1.513
## Ford Pantera L      15.8 3.170
## Ferrari Dino        19.7 2.770
## Maserati Bora       15.0 3.570
## Volvo 142E          21.4 2.780
```

```r
select(mtcars, -mpg, -wt) # Selects all but mpg and wt columns
```

```
##                     cyl  disp  hp drat  qsec vs am gear carb
## Mazda RX4             6 160.0 110 3.90 16.46  0  1    4    4
## Mazda RX4 Wag         6 160.0 110 3.90 17.02  0  1    4    4
## Datsun 710            4 108.0  93 3.85 18.61  1  1    4    1
## Hornet 4 Drive        6 258.0 110 3.08 19.44  1  0    3    1
## Hornet Sportabout     8 360.0 175 3.15 17.02  0  0    3    2
## Valiant               6 225.0 105 2.76 20.22  1  0    3    1
## Duster 360            8 360.0 245 3.21 15.84  0  0    3    4
## Merc 240D             4 146.7  62 3.69 20.00  1  0    4    2
## Merc 230              4 140.8  95 3.92 22.90  1  0    4    2
```

```
## Merc 280              6 167.6 123 3.92 18.30  1  0    4    4
## Merc 280C             6 167.6 123 3.92 18.90  1  0    4    4
## Merc 450SE            8 275.8 180 3.07 17.40  0  0    3    3
## Merc 450SL            8 275.8 180 3.07 17.60  0  0    3    3
## Merc 450SLC           8 275.8 180 3.07 18.00  0  0    3    3
## Cadillac Fleetwood    8 472.0 205 2.93 17.98  0  0    3    4
## Lincoln Continental   8 460.0 215 3.00 17.82  0  0    3    4
## Chrysler Imperial     8 440.0 230 3.23 17.42  0  0    3    4
## Fiat 128              4  78.7  66 4.08 19.47  1  1    4    1
## Honda Civic           4  75.7  52 4.93 18.52  1  1    4    2
## Toyota Corolla        4  71.1  65 4.22 19.90  1  1    4    1
## Toyota Corona         4 120.1  97 3.70 20.01  1  0    3    1
## Dodge Challenger      8 318.0 150 2.76 16.87  0  0    3    2
## AMC Javelin           8 304.0 150 3.15 17.30  0  0    3    2
## Camaro Z28            8 350.0 245 3.73 15.41  0  0    3    4
## Pontiac Firebird      8 400.0 175 3.08 17.05  0  0    3    2
## Fiat X1-9             4  79.0  66 4.08 18.90  1  1    4    1
## Porsche 914-2         4 120.3  91 4.43 16.70  0  1    5    2
## Lotus Europa          4  95.1 113 3.77 16.90  1  1    5    2
## Ford Pantera L        8 351.0 264 4.22 14.50  0  1    5    4
## Ferrari Dino          6 145.0 175 3.62 15.50  0  1    5    6
## Maserati Bora         8 301.0 335 3.54 14.60  0  1    5    8
## Volvo 142E            4 121.0 109 4.11 18.60  1  1    4    2
```

```
select(mtcars, 2, 3, 8) # Selects columns 2, 3, and 8
```

```
##                   cyl  disp vs
## Mazda RX4           6 160.0  0
## Mazda RX4 Wag       6 160.0  0
## Datsun 710          4 108.0  1
## Hornet 4 Drive      6 258.0  1
## Hornet Sportabout   8 360.0  0
## Valiant             6 225.0  1
## Duster 360          8 360.0  0
## Merc 240D           4 146.7  1
## Merc 230            4 140.8  1
## Merc 280            6 167.6  1
## Merc 280C           6 167.6  1
## Merc 450SE          8 275.8  0
## Merc 450SL          8 275.8  0
## Merc 450SLC         8 275.8  0
## Cadillac Fleetwood  8 472.0  0
## Lincoln Continental 8 460.0  0
## Chrysler Imperial   8 440.0  0
## Fiat 128            4  78.7  1
## Honda Civic         4  75.7  1
## Toyota Corolla      4  71.1  1
## Toyota Corona       4 120.1  1
## Dodge Challenger    8 318.0  0
## AMC Javelin         8 304.0  0
## Camaro Z28          8 350.0  0
## Pontiac Firebird    8 400.0  0
## Fiat X1-9           4  79.0  1
## Porsche 914-2       4 120.3  0
## Lotus Europa        4  95.1  1
```

```
## Ford Pantera L        8 351.0  0
## Ferrari Dino          6 145.0  0
## Maserati Bora         8 301.0  0
## Volvo 142E            4 121.0  1
```

```
select(mtcars, mpg:wt) #Selects all columns in the range of mpg to wt
```

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

```
select(mtcars, last_col()) # Selects the rightmost column
```

```
##                   carb
## Mazda RX4            4
## Mazda RX4 Wag        4
## Datsun 710           1
## Hornet 4 Drive       1
## Hornet Sportabout    2
## Valiant              1
## Duster 360           4
## Merc 240D            2
## Merc 230             2
## Merc 280             4
## Merc 280C            4
```

```
## Merc 450SE             3
## Merc 450SL             3
## Merc 450SLC            3
## Cadillac Fleetwood     4
## Lincoln Continental    4
## Chrysler Imperial      4
## Fiat 128               1
## Honda Civic            2
## Toyota Corolla         1
## Toyota Corona          1
## Dodge Challenger       2
## AMC Javelin            2
## Camaro Z28             4
## Pontiac Firebird       2
## Fiat X1-9              1
## Porsche 914-2          2
## Lotus Europa           2
## Ford Pantera L         4
## Ferrari Dino           6
## Maserati Bora          8
## Volvo 142E             2
```

```
select(mtcars, last_col(offset = 4))  # Selects fifth-to-last column
```

```
##                      qsec
## Mazda RX4           16.46
## Mazda RX4 Wag       17.02
## Datsun 710          18.61
## Hornet 4 Drive      19.44
## Hornet Sportabout   17.02
## Valiant             20.22
## Duster 360          15.84
## Merc 240D           20.00
## Merc 230            22.90
## Merc 280            18.30
## Merc 280C           18.90
## Merc 450SE          17.40
## Merc 450SL          17.60
## Merc 450SLC         18.00
## Cadillac Fleetwood  17.98
## Lincoln Continental 17.82
## Chrysler Imperial   17.42
## Fiat 128            19.47
## Honda Civic         18.52
## Toyota Corolla      19.90
## Toyota Corona       20.01
## Dodge Challenger    16.87
## AMC Javelin         17.30
## Camaro Z28          15.41
## Pontiac Firebird    17.05
## Fiat X1-9           18.90
## Porsche 914-2       16.70
## Lotus Europa        16.90
## Ford Pantera L      14.50
## Ferrari Dino        15.50
```

```
## Maserati Bora       14.60
## Volvo 142E          18.60
```

```
select(mtcars, starts_with("m")) # Selects the columns that start with m
```

```
##                      mpg
## Mazda RX4           21.0
## Mazda RX4 Wag       21.0
## Datsun 710          22.8
## Hornet 4 Drive      21.4
## Hornet Sportabout   18.7
## Valiant             18.1
## Duster 360          14.3
## Merc 240D           24.4
## Merc 230            22.8
## Merc 280            19.2
## Merc 280C           17.8
## Merc 450SE          16.4
## Merc 450SL          17.3
## Merc 450SLC         15.2
## Cadillac Fleetwood  10.4
## Lincoln Continental 10.4
## Chrysler Imperial   14.7
## Fiat 128            32.4
## Honda Civic         30.4
## Toyota Corolla      33.9
## Toyota Corona       21.5
## Dodge Challenger    15.5
## AMC Javelin         15.2
## Camaro Z28          13.3
## Pontiac Firebird    19.2
## Fiat X1-9           27.3
## Porsche 914-2       26.0
## Lotus Europa        30.4
## Ford Pantera L      15.8
## Ferrari Dino        19.7
## Maserati Bora       15.0
## Volvo 142E          21.4
```

```
select(mtcars, ends_with("g")) # Selects the columns that end with g
```

```
##                      mpg
## Mazda RX4           21.0
## Mazda RX4 Wag       21.0
## Datsun 710          22.8
## Hornet 4 Drive      21.4
## Hornet Sportabout   18.7
## Valiant             18.1
## Duster 360          14.3
## Merc 240D           24.4
## Merc 230            22.8
## Merc 280            19.2
## Merc 280C           17.8
## Merc 450SE          16.4
## Merc 450SL          17.3
```

```
## Merc 450SLC         15.2
## Cadillac Fleetwood  10.4
## Lincoln Continental 10.4
## Chrysler Imperial   14.7
## Fiat 128            32.4
## Honda Civic         30.4
## Toyota Corolla      33.9
## Toyota Corona       21.5
## Dodge Challenger    15.5
## AMC Javelin         15.2
## Camaro Z28          13.3
## Pontiac Firebird    19.2
## Fiat X1-9           27.3
## Porsche 914-2       26.0
## Lotus Europa        30.4
## Ford Pantera L      15.8
## Ferrari Dino        19.7
## Maserati Bora       15.0
## Volvo 142E          21.4
```

```
select(mtcars, contains("p")) # Selects the columns that contain p
```

```
##                     mpg  disp  hp
## Mazda RX4          21.0 160.0 110
## Mazda RX4 Wag      21.0 160.0 110
## Datsun 710         22.8 108.0  93
## Hornet 4 Drive     21.4 258.0 110
## Hornet Sportabout  18.7 360.0 175
## Valiant            18.1 225.0 105
## Duster 360         14.3 360.0 245
## Merc 240D          24.4 146.7  62
## Merc 230           22.8 140.8  95
## Merc 280           19.2 167.6 123
## Merc 280C          17.8 167.6 123
## Merc 450SE         16.4 275.8 180
## Merc 450SL         17.3 275.8 180
## Merc 450SLC        15.2 275.8 180
## Cadillac Fleetwood 10.4 472.0 205
## Lincoln Continental 10.4 460.0 215
## Chrysler Imperial  14.7 440.0 230
## Fiat 128           32.4  78.7  66
## Honda Civic        30.4  75.7  52
## Toyota Corolla     33.9  71.1  65
## Toyota Corona      21.5 120.1  97
## Dodge Challenger   15.5 318.0 150
## AMC Javelin        15.2 304.0 150
## Camaro Z28         13.3 350.0 245
## Pontiac Firebird   19.2 400.0 175
## Fiat X1-9          27.3  79.0  66
## Porsche 914-2      26.0 120.3  91
## Lotus Europa       30.4  95.1 113
## Ford Pantera L     15.8 351.0 264
## Ferrari Dino       19.7 145.0 175
## Maserati Bora      15.0 301.0 335
## Volvo 142E         21.4 121.0 109
```

```r
select(mtcars, -contains("p")) # Selects the columns that do not contain p
```

```
##                     cyl drat    wt  qsec vs am gear carb
## Mazda RX4             6 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag         6 3.90 2.875 17.02  0  1    4    4
## Datsun 710            4 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive        6 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout     8 3.15 3.440 17.02  0  0    3    2
## Valiant               6 2.76 3.460 20.22  1  0    3    1
## Duster 360            8 3.21 3.570 15.84  0  0    3    4
## Merc 240D             4 3.69 3.190 20.00  1  0    4    2
## Merc 230              4 3.92 3.150 22.90  1  0    4    2
## Merc 280              6 3.92 3.440 18.30  1  0    4    4
## Merc 280C             6 3.92 3.440 18.90  1  0    4    4
## Merc 450SE            8 3.07 4.070 17.40  0  0    3    3
## Merc 450SL            8 3.07 3.730 17.60  0  0    3    3
## Merc 450SLC           8 3.07 3.780 18.00  0  0    3    3
## Cadillac Fleetwood    8 2.93 5.250 17.98  0  0    3    4
## Lincoln Continental   8 3.00 5.424 17.82  0  0    3    4
## Chrysler Imperial     8 3.23 5.345 17.42  0  0    3    4
## Fiat 128              4 4.08 2.200 19.47  1  1    4    1
## Honda Civic           4 4.93 1.615 18.52  1  1    4    2
## Toyota Corolla        4 4.22 1.835 19.90  1  1    4    1
## Toyota Corona         4 3.70 2.465 20.01  1  0    3    1
## Dodge Challenger      8 2.76 3.520 16.87  0  0    3    2
## AMC Javelin           8 3.15 3.435 17.30  0  0    3    2
## Camaro Z28            8 3.73 3.840 15.41  0  0    3    4
## Pontiac Firebird      8 3.08 3.845 17.05  0  0    3    2
## Fiat X1-9             4 4.08 1.935 18.90  1  1    4    1
## Porsche 914-2         4 4.43 2.140 16.70  0  1    5    2
## Lotus Europa          4 3.77 1.513 16.90  1  1    5    2
## Ford Pantera L        8 4.22 3.170 14.50  0  1    5    4
## Ferrari Dino          6 3.62 2.770 15.50  0  1    5    6
## Maserati Bora         8 3.54 3.570 14.60  0  1    5    8
## Volvo 142E            4 4.11 2.780 18.60  1  1    4    2
```

```r
rename(mtcars, weight=wt) # Renames wt column to weight
```

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

```
mtcars <- rename(mtcars, weight=wt) # Saves to mtcars object in order to change the data frame
rename(mtcars, wt=weight) # Renames weight column back to wt
```

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

```r
mtcars <- rename(mtcars, wt=weight) # Reverts mtcars to original

filter(mtcars, cyl == 6) # Chooses only the rows where cyl is 6
```

```
##                 mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## 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
## Valiant        18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
## Merc 280       19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
## Merc 280C      17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
## Ferrari Dino   19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
```

```r
filter(mtcars, cyl == 4 & mpg < 30) # Chooses only the rows where cyl is 4 and mpg is less than 30
```

```
##                mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Datsun 710    22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## Merc 240D     24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
## Merc 230      22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
## Toyota Corona 21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## Fiat X1-9     27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## Porsche 914-2 26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## Volvo 142E    21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

```r
filter(mtcars, cyl == 4, mpg < 30) # Same as the previous result
```

```
##                mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Datsun 710    22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## Merc 240D     24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
## Merc 230      22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
## Toyota Corona 21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## Fiat X1-9     27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## Porsche 914-2 26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## Volvo 142E    21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

```r
# Pipe
mtcars |> # From mtcars, select only mpg and wt columns, then choose the rows with mpg below 30
    select(mpg, wt) |>
    filter(mpg < 30)
```

```
##                     mpg    wt
## Mazda RX4          21.0 2.620
## Mazda RX4 Wag      21.0 2.875
## Datsun 710         22.8 2.320
## Hornet 4 Drive     21.4 3.215
## Hornet Sportabout  18.7 3.440
## Valiant            18.1 3.460
## Duster 360         14.3 3.570
## Merc 240D          24.4 3.190
## Merc 230           22.8 3.150
## Merc 280           19.2 3.440
## Merc 280C          17.8 3.440
## Merc 450SE         16.4 4.070
## Merc 450SL         17.3 3.730
## Merc 450SLC        15.2 3.780
## Cadillac Fleetwood 10.4 5.250
```

```
## Lincoln Continental 10.4 5.424
## Chrysler Imperial   14.7 5.345
## Toyota Corona       21.5 2.465
## Dodge Challenger    15.5 3.520
## AMC Javelin         15.2 3.435
## Camaro Z28          13.3 3.840
## Pontiac Firebird    19.2 3.845
## Fiat X1-9           27.3 1.935
## Porsche 914-2       26.0 2.140
## Ford Pantera L      15.8 3.170
## Ferrari Dino        19.7 2.770
## Maserati Bora       15.0 3.570
## Volvo 142E          21.4 2.780
```

```
table(mtcars$cyl) |> sort() # Create a table for number of observations for each value of cyl
```

```
##
##  6  4  8
##  7 11 14
```

```
mutate(mtcars, cyl = 1 + cyl) |> # Replaces each entry for cyl with 1 greater than that value
  select(cyl)
```

```
##                     cyl
## Mazda RX4             7
## Mazda RX4 Wag         7
## Datsun 710            5
## Hornet 4 Drive        7
## Hornet Sportabout     9
## Valiant               7
## Duster 360            9
## Merc 240D             5
## Merc 230              5
## Merc 280              7
## Merc 280C             7
## Merc 450SE            9
## Merc 450SL            9
## Merc 450SLC           9
## Cadillac Fleetwood    9
## Lincoln Continental   9
## Chrysler Imperial     9
## Fiat 128              5
## Honda Civic           5
## Toyota Corolla        5
## Toyota Corona         5
## Dodge Challenger      9
## AMC Javelin           9
## Camaro Z28            9
## Pontiac Firebird      9
## Fiat X1-9             5
## Porsche 914-2         5
## Lotus Europa          5
## Ford Pantera L        9
## Ferrari Dino          7
## Maserati Bora         9
```

```
## Volvo 142E            5
```

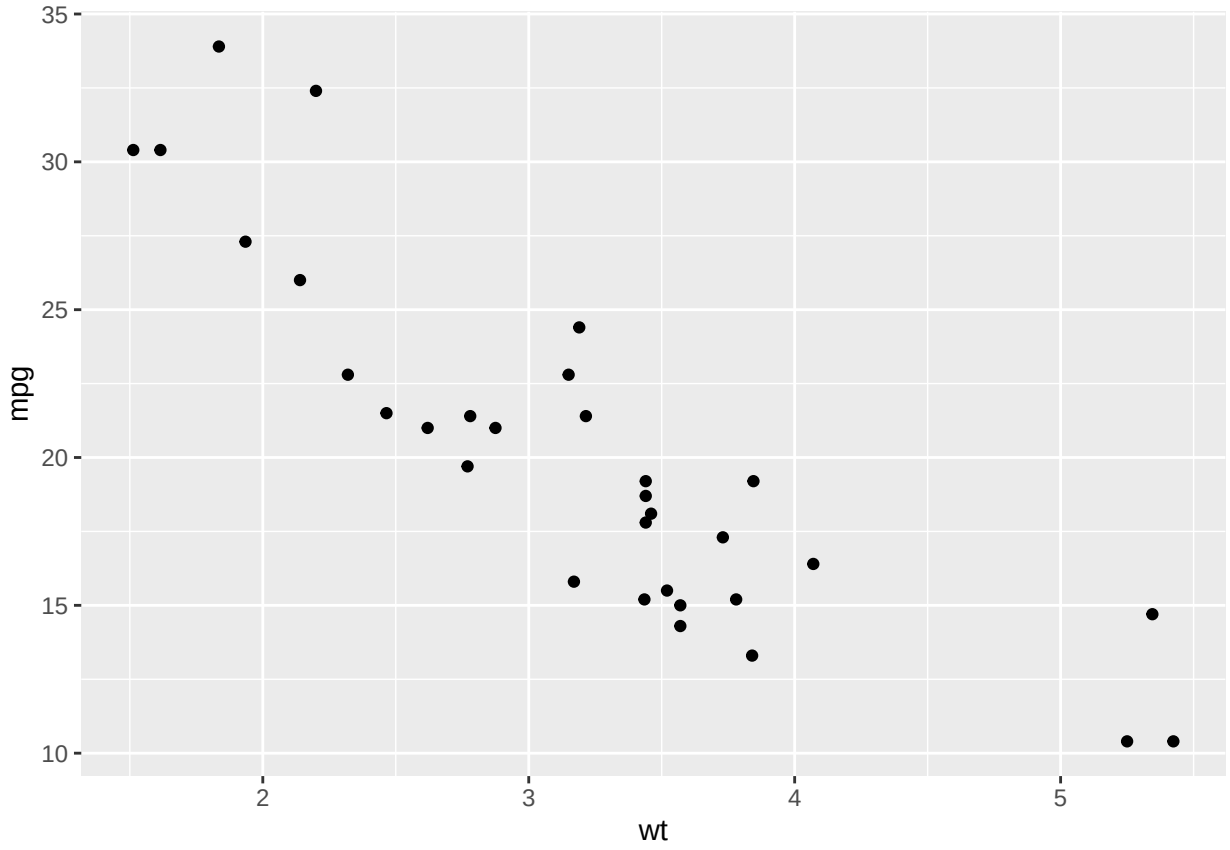
```
mtcars %>% # create hp and then use it to create hpnorm
  mutate(hp = 10 + hp,
         hpnorm = ifelse(hp < 100, 100, hp)) %>%
  select(starts_with("hp")) %>%
  filter(hp < 100)
```

```
##                hp hpnorm
## Merc 240D      72    100
## Fiat 128       76    100
## Honda Civic    62    100
## Toyota Corolla 75    100
## Fiat X1-9      76    100
```

ggplot2

```
library(ggplot2)
qplot(x = wt, y = mpg, geom = "point", data = mtcars) # Plots wt against mpg
```

```
## Warning: `qplot()` was deprecated in ggplot2 3.4.0.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

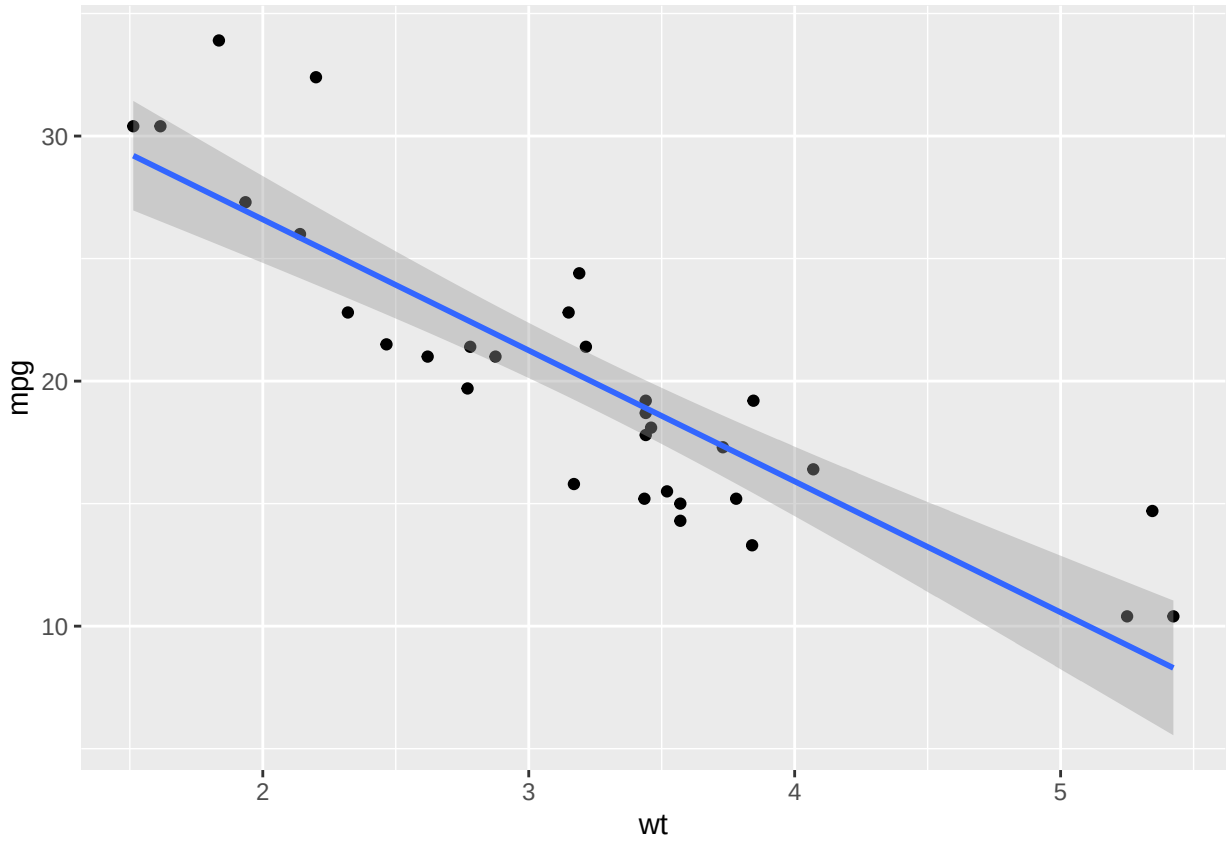



```
cor(mtcars$wt, mtcars$mpg) # Calculates correlation coefficient
```

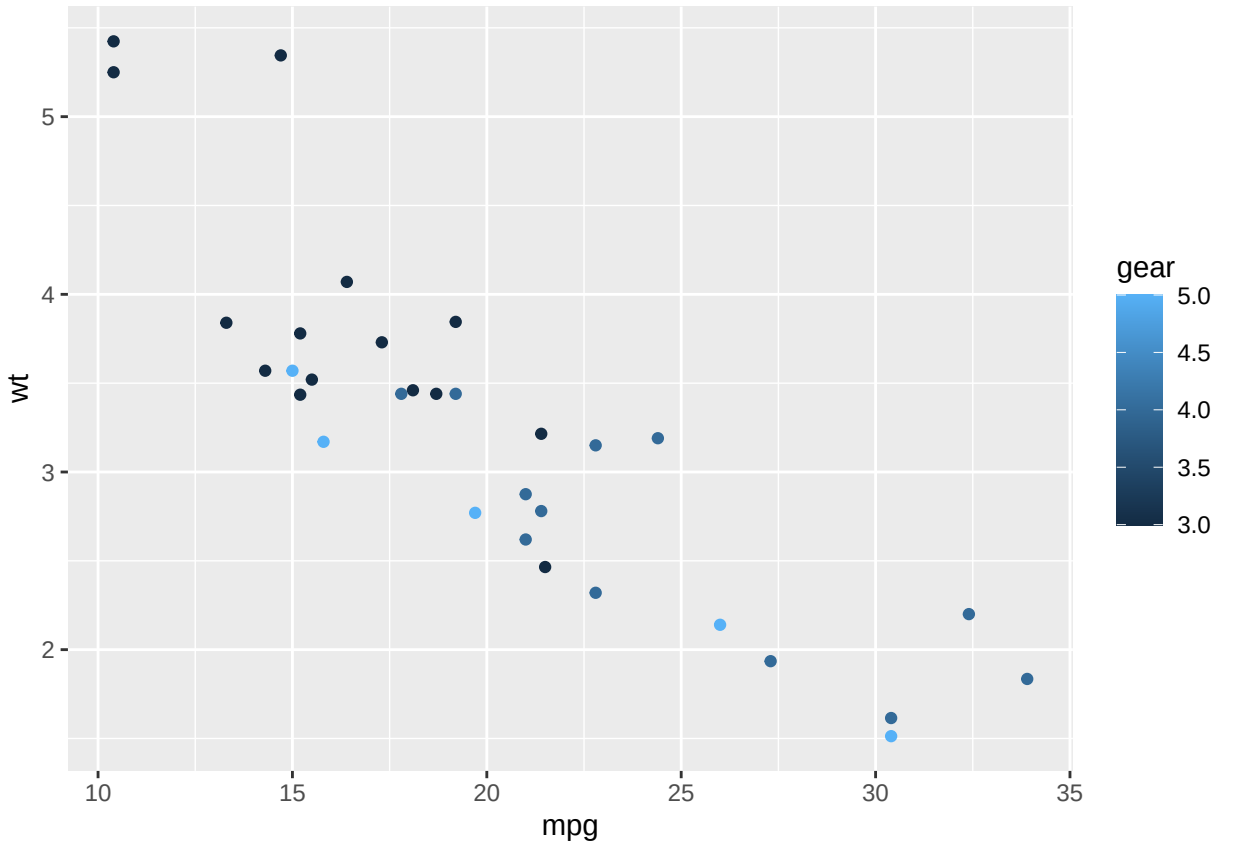
```
## [1] -0.8676594
```

```
qplot(wt, mpg, geom = "point", data = mtcars) +
    geom_smooth(method = "lm") # plots a linear regression line
```

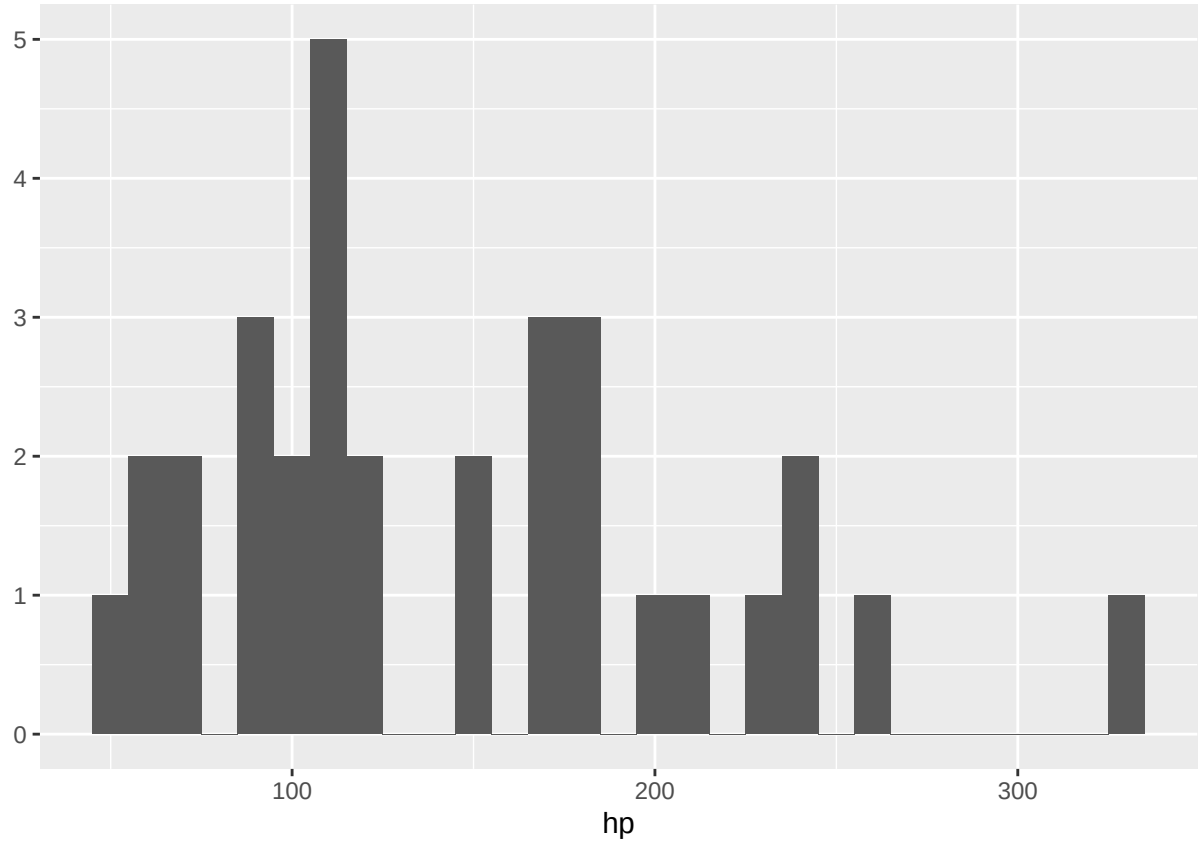
```
## `geom_smooth()` using formula = 'y ~ x'
```




```
qplot(mpg, wt, geom = "point", data = mtcars, colour = gear) # Color by gear
```




```
qplot(hp, data = mtcars, binwidth = 10) # Histogram of distribution of hp
```




```r
mtcars[which.max(mtcars$hp),] # Finds the data point with the highest hp
```

```
##               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
```

```r
mean(mtcars$hp[mtcars$vs == 0]) # Average hp when vs is 0
```

```
## [1] 189.7222
```

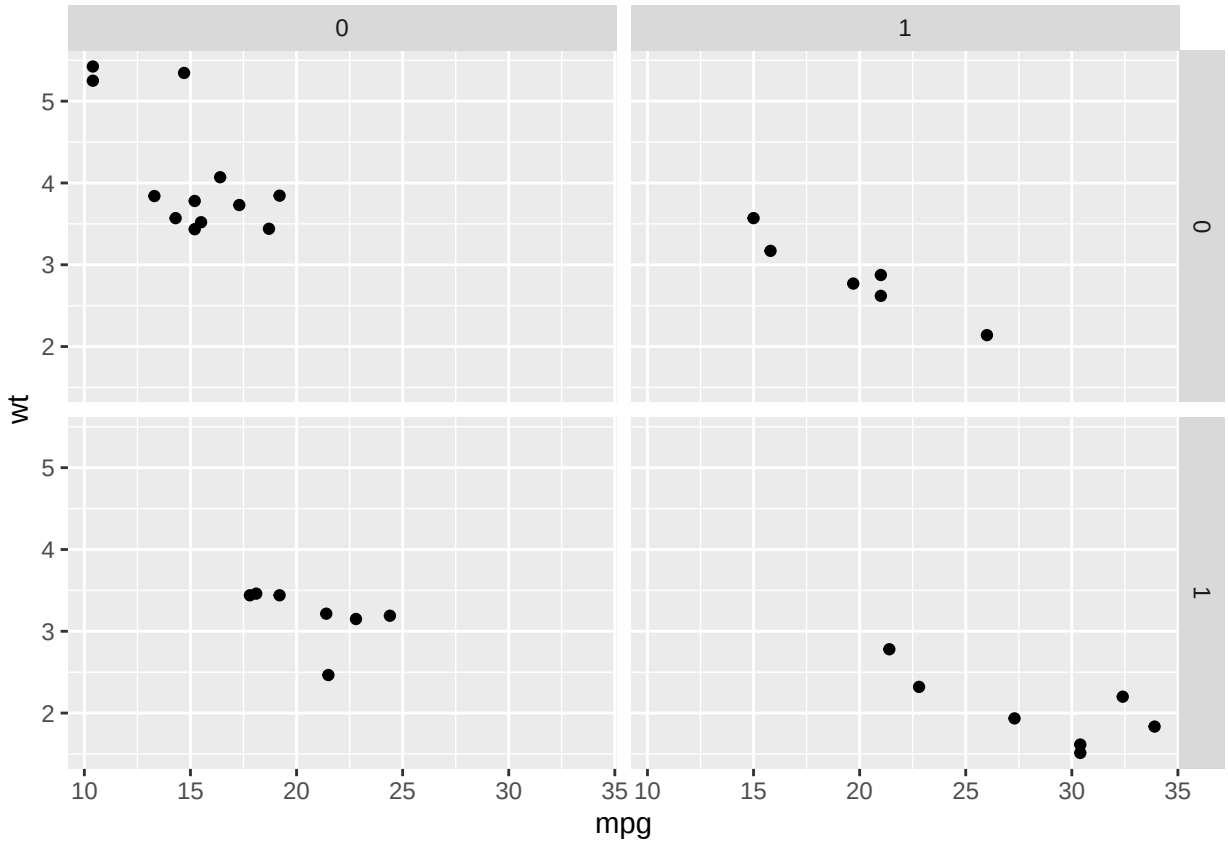
```r
mean(mtcars$hp[mtcars$vs == 1]) # Average hp when vs is 1
```

```
## [1] 91.35714
```

```r
t.test(hp ~ vs, data = mtcars) # Tests whether the means are statistically different
```

```
##
##  Welch Two Sample t-test
##
## data:  hp by vs
## t = 6.2908, df = 23.561, p-value = 1.82e-06
## alternative hypothesis: true difference in means between group 0 and group 1 is not equal to 0
## 95 percent confidence interval:
##   66.06161 130.66854
## sample estimates:
## mean in group 0 mean in group 1
##       189.72222        91.35714
```

```r
qplot(mpg, wt, geom = "point", data = mtcars, facets=vs~am) # Facetting to show whether the relationshi
```


0
1
0
1
wt
mpg
5
4
3
2
10
15
20
25
30
35