

# Assignment 9 - CT5102 Using S3

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```
library(dplyr)
```

```
##
```

```
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
```

```
##
```

```
## filter, lag
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
## intersect, setdiff, setequal, union
```

```
library(ggplot2)
```

```
library(purrr)
```

```
d1 <- mpg |> group_by(class)
```

```
d1
```

```
## # A tibble: 234 x 11
```

```
## # Groups:   class [7]
```

```
##   manufacturer model      displ  year  cyl trans drv      cty  hwy fl      class
##   <chr>          <chr>    <dbl> <int> <int> <chr> <chr> <int> <int> <chr> <chr>
## 1 audi          a4        1.8  1999    4 auto~ f      18    29 p  comp~
## 2 audi          a4        1.8  1999    4 manu~ f      21    29 p  comp~
## 3 audi          a4        2    2008    4 manu~ f      20    31 p  comp~
## 4 audi          a4        2    2008    4 auto~ f      21    30 p  comp~
## 5 audi          a4        2.8  1999    6 auto~ f      16    26 p  comp~
## 6 audi          a4        2.8  1999    6 manu~ f      18    26 p  comp~
## 7 audi          a4        3.1  2008    6 auto~ f      18    27 p  comp~
## 8 audi          a4 quattro 1.8  1999    4 manu~ 4      18    26 p  comp~
## 9 audi          a4 quattro 1.8  1999    4 auto~ 4      16    25 p  comp~
## 10 audi          a4 quattro 2    2008    4 manu~ 4      20    28 p  comp~
## # ... with 224 more rows
```

```
my_mpg_lms <- function(x){
  temp <- x |> group_split()
  mods1 <- map(temp, ~lm(cty~displ, data=..))
  class(mods1) <- "my_mpg_lms"
  names(mods1) <- group_keys(x)[[1]]
  mods1
}

mods1 <- my_mpg_lms(d1)

length(mods1)
```

```
## [1] 7
```

```
class(mods1)
```

```
## [1] "my_mpg_lms"
```

```
names(mods1)
```

```
## [1] "2seater"    "compact"    "midsize"    "minivan"    "pickup"
## [6] "subcompact" "suv"
```

```
str(mods1[[1]])
```

```
## List of 12
## $ coefficients : Named num [1:2] 17.686 -0.371
##   .. attr(*, "names")= chr [1:2] "(Intercept)" "displ"
## $ residuals    : Named num [1:5] 0.4293 -0.5707 0.6148 -0.3852 -0.0883
##   .. attr(*, "names")= chr [1:5] "1" "2" "3" "4" ...
## $ effects      : Named num [1:5] -34.435 -0.395 0.389 -0.611 -0.721
##   .. attr(*, "names")= chr [1:5] "(Intercept)" "displ" "" "" ...
## $ rank         : int 2
## $ fitted.values: Named num [1:5] 15.6 15.6 15.4 15.4 15.1
##   .. attr(*, "names")= chr [1:5] "1" "2" "3" "4" ...
## $ assign       : int [1:2] 0 1
## $ qr          : List of 5
##   ..$ qr       : num [1:5, 1:2] -2.236 0.447 0.447 0.447 0.447 ...
##   .. .. attr(*, "dimnames")=List of 2
##   .. .. ..$ : chr [1:5] "1" "2" "3" "4" ...
##   .. .. ..$ : chr [1:2] "(Intercept)" "displ"
##   .. .. attr(*, "assign")= int [1:2] 0 1
##   ..$ qraux: num [1:2] 1.45 1.3
##   ..$ pivot: int [1:2] 1 2
##   ..$ tol  : num 1e-07
##   ..$ rank : int 2
##   .. attr(*, "class")= chr "qr"
## $ df.residual  : int 3
## $ xlevels      : Named list()
## $ call         : language lm(formula = cty ~ displ, data = .)
## $ terms       :Classes 'terms', 'formula' language cty ~ displ
```

```
## ..- attr(*, "variables")= language list(cty, displ)
## ..- attr(*, "factors")= int [1:2, 1] 0 1
## ..- attr(*, "dimnames")=List of 2
## ..$ : chr [1:2] "cty" "displ"
## ..$ : chr "displ"
## ..- attr(*, "term.labels")= chr "displ"
## ..- attr(*, "order")= int 1
## ..- attr(*, "intercept")= int 1
## ..- attr(*, "response")= int 1
## ..- attr(*, ".Environment")=<environment: 0x140dbe558>
## ..- attr(*, "predvars")= language list(cty, displ)
## ..- attr(*, "dataClasses")= Named chr [1:2] "numeric" "numeric"
## ..- attr(*, "names")= chr [1:2] "cty" "displ"
## $ model      :'data.frame':  5 obs. of  2 variables:
## ..$ cty : int [1:5] 16 15 16 15 15
## ..$ displ: num [1:5] 5.7 5.7 6.2 6.2 7
## ..- attr(*, "terms")=Classes 'terms', 'formula' language cty ~ displ
## ..- attr(*, "variables")= language list(cty, displ)
## ..- attr(*, "factors")= int [1:2, 1] 0 1
## ..- attr(*, "dimnames")=List of 2
## ..$ : chr [1:2] "cty" "displ"
## ..$ : chr "displ"
## ..- attr(*, "term.labels")= chr "displ"
## ..- attr(*, "order")= int 1
## ..- attr(*, "intercept")= int 1
## ..- attr(*, "response")= int 1
## ..- attr(*, ".Environment")=<environment: 0x140dbe558>
## ..- attr(*, "predvars")= language list(cty, displ)
## ..- attr(*, "dataClasses")= Named chr [1:2] "numeric" "numeric"
## ..- attr(*, "names")= chr [1:2] "cty" "displ"
## - attr(*, "class")= chr "lm"
```

```
str(mods1[[7]])
```

```
## List of 12
## $ coefficients : Named num [1:2] 21.1 -1.7
## ..- attr(*, "names")= chr [1:2] "(Intercept)" "displ"
## $ residuals    : Named num [1:62] 1.93 -1.07 1.93 1.61 1.12 ...
## ..- attr(*, "names")= chr [1:62] "1" "2" "3" "4" ...
## $ effects      : Named num [1:62] -106.3 14.12 1.82 1.55 1.11 ...
## ..- attr(*, "names")= chr [1:62] "(Intercept)" "displ" "" "" ...
## $ rank         : int 2
## $ fitted.values: Named num [1:62] 12.1 12.1 12.1 11.4 10.9 ...
## ..- attr(*, "names")= chr [1:62] "1" "2" "3" "4" ...
## $ assign       : int [1:2] 0 1
## $ qr           :List of 5
## ..$ qr : num [1:62, 1:2] -7.874 0.127 0.127 0.127 0.127 ...
## ..- attr(*, "dimnames")=List of 2
## ..$ : chr [1:62] "1" "2" "3" "4" ...
## ..$ : chr [1:2] "(Intercept)" "displ"
## ..- attr(*, "assign")= int [1:2] 0 1
## ..$ qraux: num [1:2] 1.13 1.09
## ..$ pivot: int [1:2] 1 2
## ..$ tol : num 1e-07
```

```
## ..$ rank : int 2
## ..- attr(*, "class")= chr "qr"
## $ df.residual : int 60
## $ xlevels : Named list()
## $ call : language lm(formula = cty ~ displ, data = .)
## $ terms :Classes 'terms', 'formula' language cty ~ displ
## .. ..- attr(*, "variables")= language list(cty, displ)
## .. ..- attr(*, "factors")= int [1:2, 1] 0 1
## .. .. ..- attr(*, "dimnames")=List of 2
## .. .. ..$ : chr [1:2] "cty" "displ"
## .. .. ..$ : chr "displ"
## .. ..- attr(*, "term.labels")= chr "displ"
## .. ..- attr(*, "order")= int 1
## .. ..- attr(*, "intercept")= int 1
## .. ..- attr(*, "response")= int 1
## .. ..- attr(*, ".Environment")=<environment: 0x140f9cad0>
## .. ..- attr(*, "predvars")= language list(cty, displ)
## .. ..- attr(*, "dataClasses")= Named chr [1:2] "numeric" "numeric"
## .. .. ..- attr(*, "names")= chr [1:2] "cty" "displ"
## $ model :'data.frame': 62 obs. of 2 variables:
## ..$ cty : int [1:62] 14 11 14 13 12 14 11 11 14 13 ...
## ..$ displ: num [1:62] 5.3 5.3 5.3 5.7 6 5.3 5.3 5.7 6.5 3.9 ...
## ..- attr(*, "terms")=Classes 'terms', 'formula' language cty ~ displ
## .. .. ..- attr(*, "variables")= language list(cty, displ)
## .. .. ..- attr(*, "factors")= int [1:2, 1] 0 1
## .. .. .. ..- attr(*, "dimnames")=List of 2
## .. .. .. ..$ : chr [1:2] "cty" "displ"
## .. .. .. ..$ : chr "displ"
## .. .. ..- attr(*, "term.labels")= chr "displ"
## .. .. ..- attr(*, "order")= int 1
## .. .. ..- attr(*, "intercept")= int 1
## .. .. ..- attr(*, "response")= int 1
## .. .. ..- attr(*, ".Environment")=<environment: 0x140f9cad0>
## .. .. ..- attr(*, "predvars")= language list(cty, displ)
## .. .. ..- attr(*, "dataClasses")= Named chr [1:2] "numeric" "numeric"
## .. .. .. ..- attr(*, "names")= chr [1:2] "cty" "displ"
## - attr(*, "class")= chr "lm"
```

```
summary.my_mpg_lms <- function(x){
  cat("The following are the model groups\n")
  cat(names(x), "\n\n")
  cat("Here are the results...\n")

  walk2(names(x),x,~{
    cat("Model #", which(.x==names(x)), "Group", .x, "Obs =", nobs(.y), "\n")
    print(summary(.y))
    cat("===== \n\n")
  })
}

summary(mods1)
```

```
## The following are the model groups
## 2seater compact midsize minivan pickup subcompact suv
```

```

##
## Here are the results...
## Model # 1 Group 2seater Obs = 5
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      1      2      3      4      5
## 0.42933 -0.57067  0.61484 -0.38516 -0.08834
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  17.6855      3.4259   5.162  0.0141 *
## displ        -0.3710      0.5545  -0.669  0.5513
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.59 on 3 degrees of freedom
## Multiple R-squared:  0.1299, Adjusted R-squared:  -0.1602
## F-statistic: 0.4477 on 1 and 3 DF,  p-value: 0.5513
##
## =====
##
## Model # 2 Group compact Obs = 47
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.4820 -1.5340 -0.0021  1.2060 10.9660
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   30.546      2.117  14.428 < 2e-16 ***
## displ         -4.480      0.894  -5.011 8.86e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.742 on 45 degrees of freedom
## Multiple R-squared:  0.3582, Adjusted R-squared:  0.3439
## F-statistic: 25.11 on 1 and 45 DF,  p-value: 8.86e-06
##
## =====
##
## Model # 3 Group midsize Obs = 41
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.9485 -0.9485 -0.3708  1.1559  3.5782

```

```
##
## Coefficients:
##           Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.3661      1.0604  22.035 < 2e-16 ***
## displ       -1.5777      0.3527  -4.474 6.48e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.603 on 39 degrees of freedom
## Multiple R-squared:  0.3392, Adjusted R-squared:  0.3222
## F-statistic: 20.02 on 1 and 39 DF,  p-value: 6.481e-05
##
## =====
##
## Model # 4 Group minivan Obs = 11
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.9476 -0.0916  0.6251  0.9099  1.0524
##
## Coefficients:
##           Estimate Std. Error t value Pr(>|t|)
## (Intercept)   20.647      4.322   4.777  0.001 **
## displ        -1.424      1.264  -1.126  0.289
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.81 on 9 degrees of freedom
## Multiple R-squared:  0.1236, Adjusted R-squared:  0.02617
## F-statistic: 1.269 on 1 and 9 DF,  p-value: 0.2891
##
## =====
##
## Model # 5 Group pickup Obs = 33
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.4959 -0.6014  0.1786  0.6508  2.2930
##
## Coefficients:
##           Estimate Std. Error t value Pr(>|t|)
## (Intercept)   20.9036      1.3740  15.213 6.30e-16 ***
## displ        -1.7889      0.3058  -5.849 1.89e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.433 on 31 degrees of freedom
## Multiple R-squared:  0.5246, Adjusted R-squared:  0.5093
```

```
## F-statistic: 34.21 on 1 and 31 DF, p-value: 1.885e-06
##
## =====
##
## Model # 6 Group subcompact Obs = 35
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.2503 -2.1134 -0.3123  1.0527 12.3264
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   28.429      1.437   19.787 < 2e-16 ***
## displ        -3.029      0.500   -6.058 8.13e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.214 on 33 degrees of freedom
## Multiple R-squared:  0.5265, Adjusted R-squared:  0.5122
## F-statistic: 36.7 on 1 and 33 DF, p-value: 8.134e-07
##
## =====
##
## Model # 7 Group suv Obs = 62
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.0868 -1.0266 -0.0868  1.0962  3.9667
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   21.0601      0.8931   23.58 < 2e-16 ***
## displ        -1.6964      0.1950   -8.70 3.17e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.623 on 60 degrees of freedom
## Multiple R-squared:  0.5578, Adjusted R-squared:  0.5504
## F-statistic: 75.69 on 1 and 60 DF, p-value: 3.168e-12
##
## =====
```

```
d2 <- mpg %>% group_by(manufacturer)
mods2 <- my_mpg_lms(d2)
names(mods2)
```

```
## [1] "audi"      "chevrolet" "dodge"      "ford"      "honda"
## [6] "hyundai"   "jeep"       "land rover" "lincoln"   "mercury"
```

```
## [11] "nissan"      "pontiac"     "subaru"      "toyota"      "volkswagen"
```

```
summary(mods2)
```

```
## The following are the model groups
## audi chevrolet dodge ford honda hyundai jeep land rover lincoln mercury nissan pontiac subaru toyota
##
## Here are the results...
## Model # 1 Group audi Obs = 18
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.9145 -1.1014  0.3615  1.3430  2.4357
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  22.0659      1.5455  14.277  1.6e-10 ***
## displ       -1.7508      0.5883  -2.976  0.00891 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.633 on 16 degrees of freedom
## Multiple R-squared:  0.3563, Adjusted R-squared:  0.3161
## F-statistic: 8.857 on 1 and 16 DF,  p-value: 0.008913
##
## =====
##
## Model # 2 Group chevrolet Obs = 19
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.6378 -0.8319 -0.0730  1.4681  2.9622
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  22.7436      1.8906  12.030  9.69e-10 ***
## displ       -1.5294      0.3611  -4.235  0.000557 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.099 on 17 degrees of freedom
## Multiple R-squared:  0.5134, Adjusted R-squared:  0.4848
## F-statistic: 17.94 on 1 and 17 DF,  p-value: 0.0005573
##
## =====
##
## Model # 3 Group dodge Obs = 37
##
```



```

## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.3415 -0.4771  0.5229  0.9780  2.5688
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  22.0931      1.5103   14.629 < 2e-16 ***
## displ       -2.0460      0.3385   -6.044 6.76e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.763 on 35 degrees of freedom
## Multiple R-squared:  0.5107, Adjusted R-squared:  0.4967
## F-statistic: 36.53 on 1 and 35 DF,  p-value: 6.763e-07
##
## =====
##
## Model # 4 Group ford Obs = 25
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.8450 -0.8450 -0.2984  1.1550  2.2170
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  24.9884      2.4596   10.160 5.67e-10 ***
## displ       -2.4225      0.5386   -4.498 0.000163 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.427 on 23 degrees of freedom
## Multiple R-squared:  0.468, Adjusted R-squared:  0.4448
## F-statistic: 20.23 on 1 and 23 DF,  p-value: 0.0001627
##
## =====
##
## Model # 5 Group honda Obs = 9
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.1316 -1.1316 -0.1316  1.1053  2.8684
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  35.026      7.696    4.551 0.00263 **

```

```

## displ          -6.184          4.483  -1.379  0.21023
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.842 on 7 degrees of freedom
## Multiple R-squared:  0.2137, Adjusted R-squared:  0.1014
## F-statistic: 1.903 on 1 and 7 DF,  p-value: 0.2102
##
## =====
##
## Model # 6 Group hyundai Obs = 14
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.1785 -0.6917 -0.4484  0.6240  2.3083
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   22.798      2.648   8.609 1.76e-06 ***
## displ        -1.711      1.079  -1.585   0.139
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.419 on 12 degrees of freedom
## Multiple R-squared:  0.1732, Adjusted R-squared:  0.1043
## F-statistic: 2.513 on 1 and 12 DF,  p-value: 0.1389
##
## =====
##
## Model # 7 Group jeep Obs = 8
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.2834  0.1026  0.6102  0.7302  1.4491
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   21.4262      3.3569   6.383 0.000696 ***
## displ        -1.7325      0.7184  -2.412 0.052466 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.93 on 6 degrees of freedom
## Multiple R-squared:  0.4922, Adjusted R-squared:  0.4076
## F-statistic: 5.815 on 1 and 6 DF,  p-value: 0.05247
##
## =====
##

```

```

## Model # 8 Group land rover Obs = 4
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      1      2      3      4
## -0.5  0.5  0.5 -0.5
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.150e+01  6.808e+00   1.689   0.233
## displ       -2.483e-16  1.581e+00   0.000   1.000
##
## Residual standard error: 0.7071 on 2 degrees of freedom
## Multiple R-squared:      0, Adjusted R-squared:   -0.5
## F-statistic:      0 on 1 and 2 DF, p-value: 1
##
## =====
##
## Model # 9 Group lincoln Obs = 3
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      1      2      3
## -0.3333 -0.3333  0.6667
##
## Coefficients: (1 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  11.3333      0.3333     34 0.000864 ***
## displ              NA              NA      NA      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5774 on 2 degrees of freedom
##
## =====
##
## Model # 10 Group mercury Obs = 4
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      1      2      3      4
## 0.52778 -0.47222 -0.13889  0.08333
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  15.6944      2.6761   5.865  0.0279 *
## displ       -0.5556      0.6054  -0.918  0.4557
## ---

```

```

## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5137 on 2 degrees of freedom
## Multiple R-squared:  0.2963, Adjusted R-squared:  -0.05556
## F-statistic: 0.8421 on 1 and 2 DF,  p-value: 0.4557
##
## =====
##
## Model # 11 Group nissan Obs = 13
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.9813 -1.7783  0.2217  1.6402  2.5325
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   28.237      2.503   11.282 2.19e-07 ***
## displ        -3.108      0.742   -4.188 0.00152 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.222 on 11 degrees of freedom
## Multiple R-squared:  0.6146, Adjusted R-squared:  0.5796
## F-statistic: 17.54 on 1 and 11 DF,  p-value: 0.001515
##
## =====
##
## Model # 12 Group pontiac Obs = 5
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      1      2      3      4      5
## 0.2757 -1.1348 -0.1348  0.8652  0.1286
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   20.3354      2.1071   9.651 0.00236 **
## displ        -0.8423      0.5234  -1.609 0.20597
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.846 on 3 degrees of freedom
## Multiple R-squared:  0.4632, Adjusted R-squared:  0.2843
## F-statistic: 2.589 on 1 and 3 DF,  p-value: 0.206
##
## =====
##
## Model # 13 Group subaru Obs = 14
##

```

```

## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.1667 -0.7917 -0.1667  0.8333  1.0000
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   26.111      5.620   4.646 0.000564 ***
## displ        -2.778      2.285  -1.216 0.247489
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8975 on 12 degrees of freedom
## Multiple R-squared:  0.1096, Adjusted R-squared:  0.03545
## F-statistic: 1.478 on 1 and 12 DF,  p-value: 0.2475
##
## =====
##
## Model # 14 Group toyota Obs = 34
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.4338 -1.7688 -0.2217  1.3147  5.3480
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   29.0882      1.3496  21.553 < 2e-16 ***
## displ        -3.5757      0.4365  -8.193 2.34e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.335 on 32 degrees of freedom
## Multiple R-squared:  0.6772, Adjusted R-squared:  0.6671
## F-statistic: 67.12 on 1 and 32 DF,  p-value: 2.337e-09
##
## =====
##
## Model # 15 Group volkswagen Obs = 27
##
## Call:
## lm(formula = cty ~ displ, data = .)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.289 -2.102 -1.252  0.342 12.230
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   32.626      4.078   8.000 2.35e-08 ***

```

```
## displ          -5.187      1.775  -2.922  0.00729 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.012 on 25 degrees of freedom
## Multiple R-squared:  0.2545, Adjusted R-squared:  0.2247
## F-statistic: 8.535 on 1 and 25 DF,  p-value: 0.007285
##
## =====
```