

Stat 021 S 21

Class 22 Worksheet

Instructions:

Use the data below to answer the following questions for each of the three models specified.

```
library("tidyverse")

## -- Attaching packages ----- tidyverse 1.3.0 --
## v ggplot2 3.3.2      v purrr   0.3.4
## v tibble  3.0.4      v dplyr  1.0.2
## v tidyr   1.1.2      v stringr 1.4.0
## v readr   1.3.1      v forcats 0.5.0

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()

mileage <- read_table2(url("http://www.swarthmore.edu/NatSci/sthornt1/DataFiles/mileage.txt"),
  skip=2, col_names = c("car", "mpg", "displacement", "weight", "transmission_type"),
  cols(transmission_type = col_factor())) %>% na.omit
## Note that transmission_type is already a factor!
head(mileage)

## # A tibble: 6 x 5
##   car      mpg displacement weight transmission_type
##   <chr>    <dbl>         <dbl>   <dbl>   <fct>
## 1 Apollo   18.9           350    3910 A
## 2 Omega    17            350    2860 A
## 3 Nova     20            250    3510 A
## 4 Monarch  18.2           351    3890 A
## 5 Duster   20.1           225    3365 M
## 6 JensonConv 11.2           440    4215 A
```

Model 1

Fit a main effects model with transmission type (A as the reference level) and displacement as the predictors and mileage as the response:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 * \text{displacement} + \hat{\beta}_2 * \text{transmission_typeM},$$

where *displacement* = the displacement of the engine and

$$\text{transmission_typeM} = \begin{cases} 1, & \text{if transmission type is manual} \\ 0, & \text{otherwise} \end{cases}.$$

```
mod1 <- lm(mpg ~ displacement + transmission_type, mileage)
summary(mod1)
```

```
##
## Call:
## lm(formula = mpg ~ displacement + transmission_type, data = mileage)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.9153 -1.8679  0.1302  1.7907  6.7826
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    33.101927   3.068171  10.789 1.15e-11 ***
## displacement   -0.045742   0.008694  -5.262 1.23e-05 ***
## transmission_typeM 0.517276   2.227587   0.232  0.818
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.117 on 29 degrees of freedom
## Multiple R-squared:  0.7724, Adjusted R-squared:  0.7567
## F-statistic: 49.2 on 2 and 29 DF,  p-value: 4.779e-10
```

1. What is the average effect on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?
2. What is the average effect on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
3. What is the average effect of engine displacement on gasoline mileage?
4. What is the average effect of engine displacement on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
5. What is the average effect of vehicle weight on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?

Model 2

Fit a main effects model with transmission type (M as the reference level) and displacement as the predictors and mileage as the response:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 * \text{displacement} + \hat{\beta}_2 * \text{transmission_typeA},$$

where *displacement* = the displacement of the engine and

$$\text{transmission_typeA} = \begin{cases} 1, & \text{if transmission type is automatic} \\ 0, & \text{otherwise} \end{cases}.$$

```
mod2 <- lm(mpg ~ displacement + relevel(transmission_type, "M"), mileage)
summary(mod2)
```

```
##
## Call:
## lm(formula = mpg ~ displacement + relevel(transmission_type,
##      "M"), data = mileage)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.9153 -1.8679  0.1302  1.7907  6.7826
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    33.619203    1.541084   21.815 < 2e-16 ***
## displacement   -0.045742    0.008694   -5.262 1.23e-05 ***
## relevel(transmission_type, "M")A -0.517276    2.227587   -0.232  0.818
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.117 on 29 degrees of freedom
## Multiple R-squared:  0.7724, Adjusted R-squared:  0.7567
## F-statistic: 49.2 on 2 and 29 DF,  p-value: 4.779e-10
```

1. What is the average effect on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?
2. What is the average effect on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
3. What is the average effect of engine displacement on gasoline mileage?
4. What is the average effect of engine displacement on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
5. What is the average effect of vehicle weight on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?

Model 3

Fit an interaction effects model with transmission type (A as the reference level) and displacement as the predictors and mileage as the response:

$$\hat{y} = \hat{\beta}_0 + (\hat{\beta}_1 * \text{displacement}) + (\hat{\beta}_2 * \text{transmission_typeM}) + (\hat{\beta}_4 * \text{displacement} * \text{transmission_typeM}),$$

where *displacement* = the displacement of the engine and

$$\text{transmission_typeM} = \begin{cases} 1, & \text{if transmission type is manual} \\ 0, & \text{otherwise} \end{cases}.$$

```
mod3 <- lm(mpg ~ displacement + transmission_type + displacement*transmission_type, mileage)
summary(mod3)
```

```
##
## Call:
## lm(formula = mpg ~ displacement + transmission_type + displacement *
##     transmission_type, data = mileage)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -6.2712 -1.2660  0.1412  1.5336  4.6750
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    29.436591    2.702869   10.891 1.42e-11 ***
## displacement   -0.035116    0.007681   -4.572 8.94e-05 ***
## transmission_typeM  13.483040    3.846945    3.505 0.001557 **
## displacement:transmission_typeM -0.081659    0.021292   -3.835 0.000653 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.568 on 28 degrees of freedom
## Multiple R-squared:  0.8508, Adjusted R-squared:  0.8348
## F-statistic: 53.21 on 3 and 28 DF,  p-value: 1.092e-11
```

1. What is the average effect on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?
2. What is the average effect on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
3. What is the average effect of engine displacement on gasoline mileage?
4. What is the average effect of engine displacement on gasoline mileage when we go from a car with an manual transmission to an automatic transmission?
5. What is the average effect of vehicle weight on gasoline mileage when we go from a car with an automatic transmission to a manual transmission?