Data Analysis of Cars Performance | Motor Trend Magazine

How does transmission type inffluences Miles Per Gallon?

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Contents

Executive Summary

In this post we'll perform some data analysis in regard to transmission type and miles per gallon (MPG). We'll seek to answer 2 main questions:

- "Is an automatic or manual transmission better for MPG"?
- How can we "Quantify the MPG difference between automatic and manual transmissions"?

Data Exploration

Introduction to dataframe used

We are going to use a famous dataframe in R, called `mtcars`. Here is a brief explanation about it:

> The data was extracted from the 1974 Motor Trend US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973–74 models).
>
> Format: A data frame with 32 observations on 11 (numeric) variables. [, 1] mpg Miles/(US) gallon [, 2] cyl Number of cylinders [, 3] disp Displacement (cu.in.) [, 4] hp Gross horsepower [, 5] drat Rear axle ratio [, 6] wt Weight (1000 lbs) [, 7] qsec 1/4 mile time [, 8] vs Engine (0 = V-shaped, 1 = straight) [, 9] am Transmission (0 = automatic, 1 = manual) [,10] gear Number of forward gears [,11] carb Number of carburetors

Load data and process it

In this section we load libraries, load data and modify it to a more tidy form.

```
library(tidyverse)
library(magrittr)
library(GGally)
library(knitr)
library(glue)
library(ggfortify)
library(broom)

# set seed for reproducibility
set.seed(1)

d <- mtcars %>%
        as_tibble() %>%
        mutate(am = factor(am, labels = c("Automatic", "Manual")),
               vs = factor(vs, labels = c("V", "S")),
               cyl = factor(cyl))

summary_d <- tibble(
    "Number of Rows" = nrow(d),
    "Number of Columns" = ncol(d)
)

# show dataframe info
kable(
    summary_d,
    caption = "A summary of the dimensions of `mtcars` dataframe"
    )
```

Table 1: A summary of the dimensions of `mtcars` dataframe

Number of Rows	Number of Columns
32	11

```
kable(
    sample_n(d, 5),
    caption = "A quick look at the raw data"
)
```

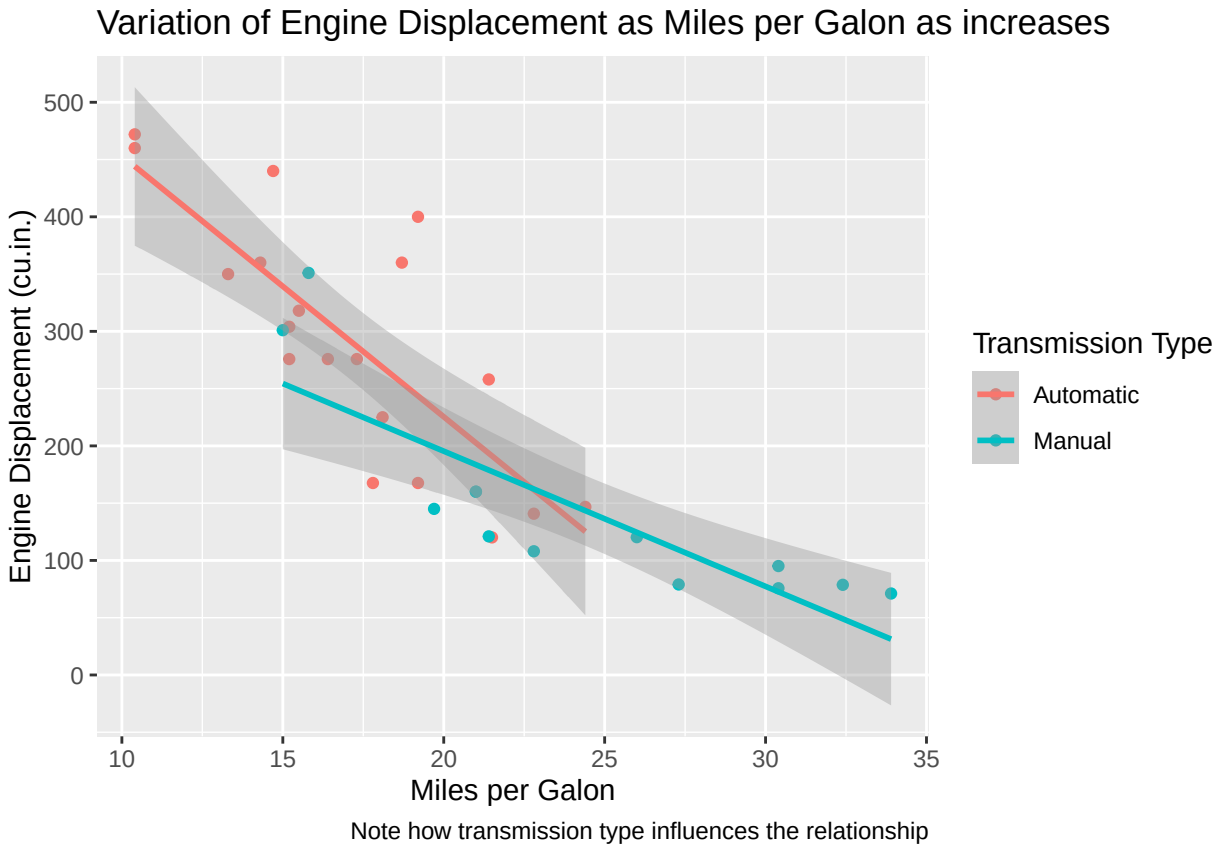
Table 2: A quick look at the raw data

mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
19.2	8	400	175	3.08	3.845	17.05	V	Automatic	3	2
21.4	6	258	110	3.08	3.215	19.44	S	Automatic	3	1
14.3	8	360	245	3.21	3.570	15.84	V	Automatic	3	4
21.0	6	160	110	3.90	2.620	16.46	V	Manual	4	4
21.0	6	160	110	3.90	2.875	17.02	V	Manual	4	4

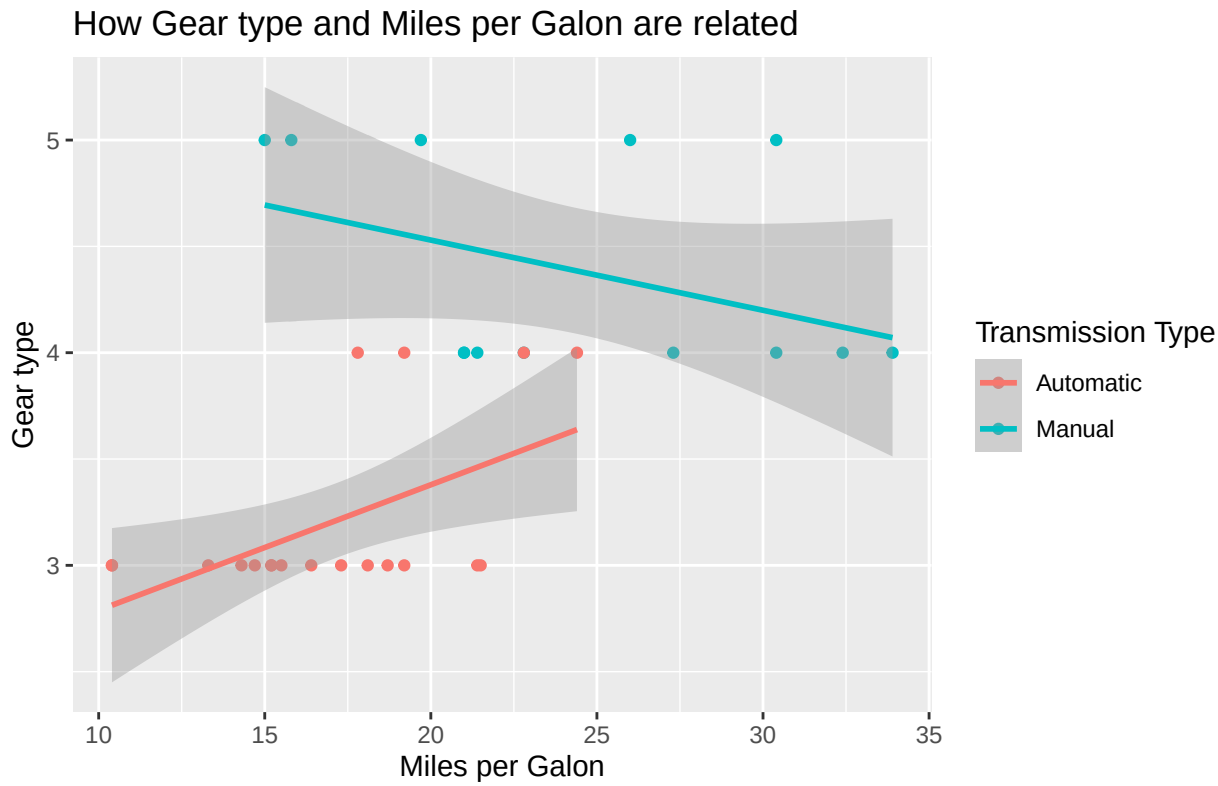
Basic visualization of the data

Here we show some basic plots demonstrating properties of the data.

```
ggplot(d) +
    geom_point(aes(mpg, disp, color = am)) +
    geom_smooth(aes(mpg, disp, color = am), method = "lm") +
    labs(
        title = "Variation of Engine Displacement as Miles per Galon as increases",
        caption = "Note how transmission type influences the relationship",
        x = "Miles per Galon",
        y = "Engine Displacement (cu.in.)"
    ) +
    scale_color_discrete(name = "Transmission Type")
```

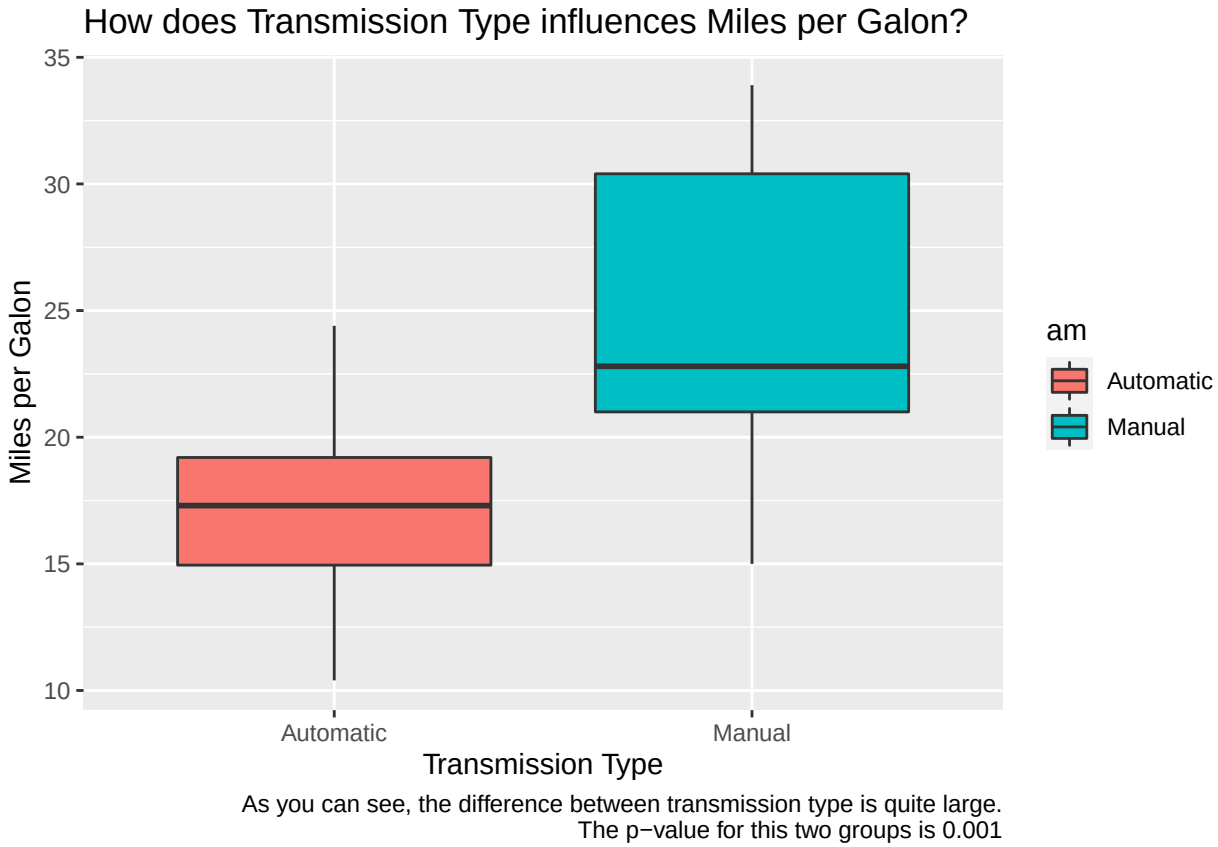



```
ggplot(d) +
    geom_point(aes(mpg, gear, color = am)) +
    geom_smooth(aes(mpg, gear, color = am), method = "lm") +
    labs(
        title = "How Gear type and Miles per Galon are related",
        caption = "Note how automatic cars tend to have a positive association between Miles per Galon a
        The same does not occour with manual cars.",
        x = "Miles per Galon",
        y = "Gear type"
    ) +
    scale_color_discrete(name = "Transmission Type")
```



w automatic cars tend to have a positive association between Miles per Galon and Gear. The same does not occour with manual cars.

```
plot_t.test <- t.test(d$mpg ~ d$am)
ggplot(d) +
    geom_boxplot(aes(am, mpg, fill = am)) +
    scale_color_discrete(name = "Transmission Type") +
    labs(
        title = "How does Transmission Type influences Miles per Galon?",
        x = "Transmission Type",
        y = "Miles per Galon",
        caption = glue(
            "As you can see, the difference between transmission type is quite large.
            The p-value for this two groups is {round(plot_t.test$p.value, 3)}
            "
        )
    )
```




```
kable(plot_t.test$estimate, caption = "Summary of variation between transmission types")
```

Table 3: Summary of variation between transmission types

	x
mean in group Automatic	17.14737
mean in group Manual	24.39231

Modeling data

Now we go one step further and perform some statistical modeling.

```
cars_t.test <- t.test(d$mpg ~ d$am) %>%
               tidy()
kable(cars_t.test, caption = "Student's T-test for `mtcars` dataframe")
```

Table 4: Student's T-test for `mtcars` dataframe

estimate	estimate1	estimate2	statistic	p.value	parameter	conf.low	conf.high	method
-7.244939	17.14737	24.39231	-3.767123	0.0013736	18.33225	-11.28019	-3.209684	Welch Two Sample t-test

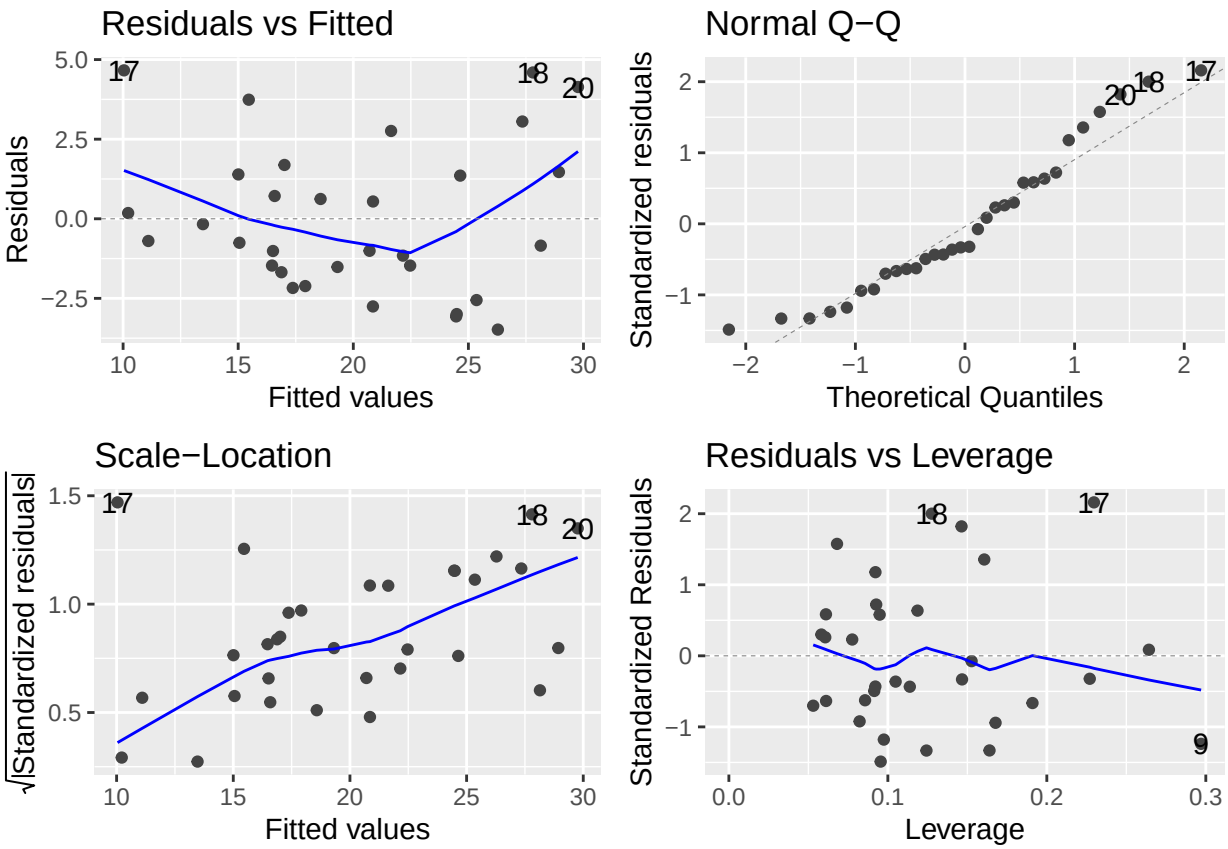
```
cars_regression <- lm(mpg ~ ., data = d) %>%
                tidy()
kable(cars_regression, caption = "Linear Regression Model for `mtcars` dataframe")
```

Table 5: Linear Regression Model for `mtcars` dataframe

term	estimate	std.error	statistic	p.value
(Intercept)	17.8198433	16.3060232	1.0928381	0.2874542
cyl6	-1.6603067	2.2622966	-0.7339032	0.4715245
cyl8	1.6374398	4.3157345	0.3794116	0.7083808
disp	0.0139124	0.0174018	0.7994830	0.4334036
hp	-0.0461284	0.0271202	-1.7008869	0.1044619
drat	0.0263503	1.6764895	0.0157175	0.9876155
wt	-3.8062476	1.8466431	-2.0611712	0.0525285
qsec	0.6469571	0.7219502	0.8961242	0.3808461
vsS	1.7473869	2.2726721	0.7688689	0.4509559
amManual	2.6172655	2.0047494	1.3055325	0.2065309
gear	0.7640292	1.4566802	0.5245003	0.6056959
carb	0.5093512	0.9424418	0.5404590	0.5948487

Finally we make a panel plot to show how is the residual of the model.

```
cars_model <- lm(mpg ~ ., data = d)
plot_residual <- autoplot(
                    step(cars_model,
                         direction="both",
                         trace=FALSE)
)
plot_residual
```



Conclusions

As we can see from this tables and plots, MPG values tend to be highly influence by gear type. Answering our initial questions:

- "Is an automatic or manual transmission better for MPG"?
  - Answer: Cars with manual transmissions are generally better when seeking better miles per gallon values.
- How can we "Quantify the MPG difference between automatic and manual transmissions"?
  - Answer: Looking at the previous boxplot and t.test we can easily quantify this difference.