RegressionModel_Week4_Project

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EXECUTIVE SUMMARY

This analysis uses the 1974 Motor Trend data to answer the following: Is an automatic or manual transmission better for miles per gallon (MPG)? What is the difference between automatic and manual transmissions? Information about the data can be found in Appendix 1.1. The analysis indicates that when adjusting for differences in other variables, the automatic and manual transmissions had similar miles per gallon. Comparing the automatic to manual transmission they appear to have several notable differences. For example, the manual transmission has higher miles per gallon (17.1 vs 24.3), higher displacement (290 vs 143 cu.in.), and horsepower (160 vs 126). This analysis has limitations. The data set included only a small sample size (32 observations). This limits the ability to generalize beyond this analysis.

Research Question 1: Is an automatic or manual transmission better for miles per gallon (MPG)?

The dependent variable, miles per gallon, is a continuous variable, so we will use a linear regression model. The independent variable transmission is binary. It appears that some variables might be confounders and should be adjusted for in the linear rgression model. There are two models considered in this analysis:

Model 1: indicates that the manual transmission has a significantly higher mile per gallon compared to the automatic tranmission (7.245 mpg higher; p=0.0002).

Model 2: indicates that after adjusting for number of cylinders, weight, and horsepower, there is no significant difference between the manual and automatic transmission in miles per gallon.

| Predictors	mpg			mpg		
	Estimates	CI	p	Estimates	CI	p
(Intercept)	17.15	14.94 – 19.35	**<0.001**	33.71	28.60 – 38.81	**<0.001**
Manual	7.24	3.79 – 10.70	**<0.001**	1.81	-0.93 – 4.55	0.206
6cyl				-3.03	-5.79 – -0.27	**0.041**
8cyl				-2.16	-6.64 – 2.31	0.352
wt				-2.50	-4.23 – -0.76	**0.009**
hp				-0.03	-0.06 – -0.01	**0.027**
Observations	32			32		
R^2 / adjusted R^2	0.360 / 0.338			0.866 / 0.840		

To compare Model 1 and Model 2, an Analysis of Variance (ANOVA) was used. The ANOVA can be found in Appendix 1.2. The p-value for the ANOVA tests whether the adjustment variables are necessary. The ANOVA indicates that Model 2 with the adjustment variables is necessary over Model 1. From these results, the adjustment variables are necessary, and adjusting for these variables indicate that there is not a significant difference in miles per gallon when comparing the automatic and manual transmissions. The residual plots of Models 1 and 2 can be found in Appendix 1.2.

Research Question 2: What is the difference between automatic and manual transmissions?

To quantify the differences between the automatic and manual transmission, descriptives methods and graphgs are used. The table provides the mean for each variable by transmission type. Graph A shows the difference in the number of cylinders by transmission type. Graph B shows the above and below average miles per gallon for each type of transmission. Graph C is a regression plot of miles per gallon on weight, by transmission type. Graph C shows the distribution of weight by transmission type. A full descriptive analysis can be found in Appendix 1.3.

1974 Motor Trend, averages by Transmission, 0=automatic, 1=manual

am	mpg	cyl	disp	hp	drat	wt	qsec	vs	gear	carb
0	17.14737	6.947368	290.3789	160.2632	3.286316	3.768895	18.18316	0.3684211	3.210526	2.736842
1	24.39231	5.076923	143.5308	126.8462	4.050000	2.411000	17.36000	0.5384615	4.384615	2.923077

A Histogram of Cylinders (count) by Transmission Type
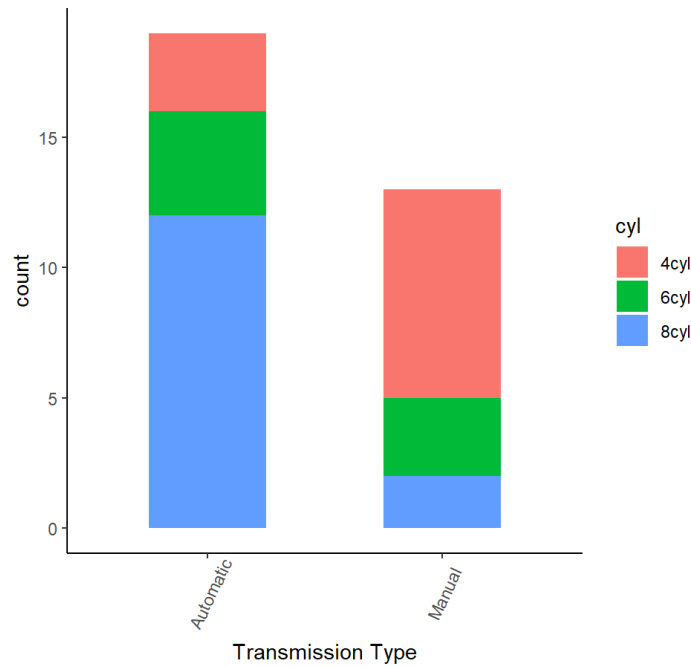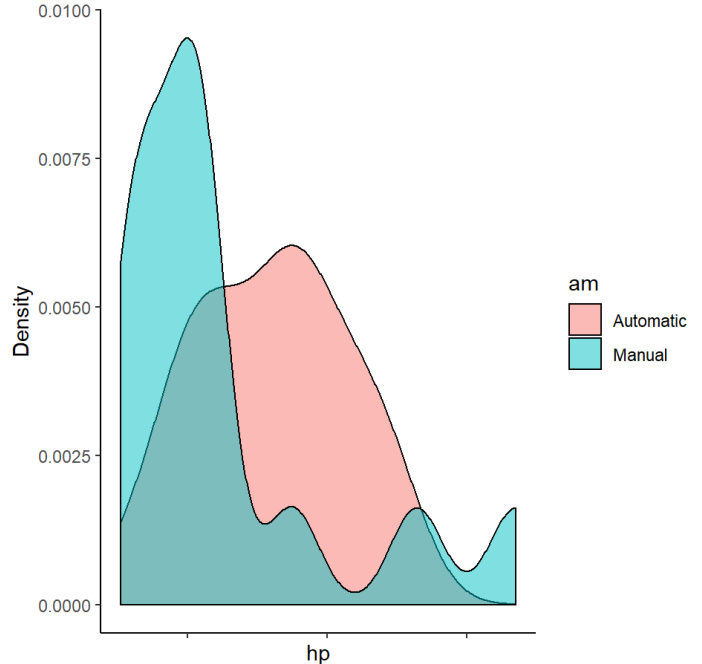

B Diverging Bars
Normalized mileage from 'mtcars'
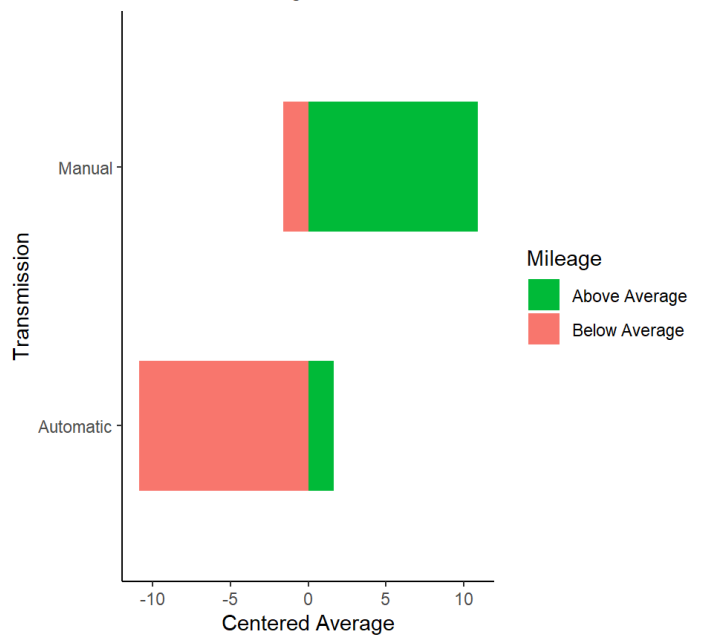
C Regression of MPG on Weight by Transmission Type
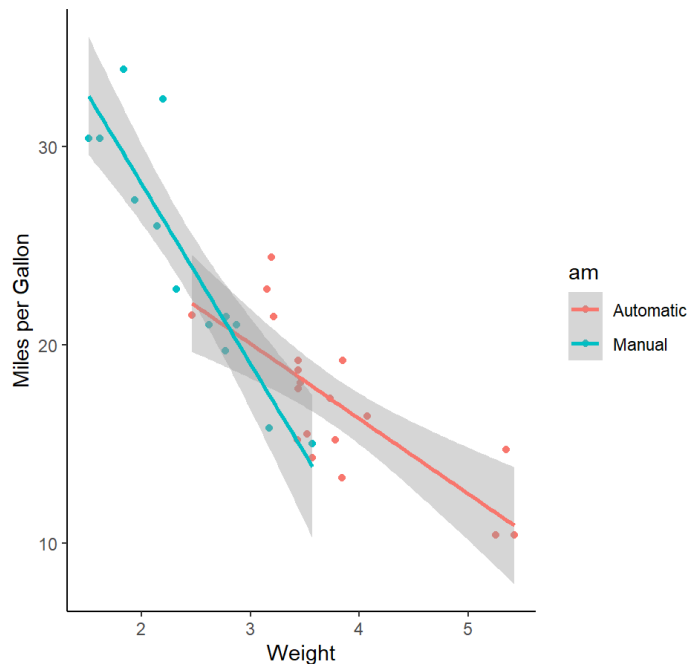
D Distribution of Horsepower
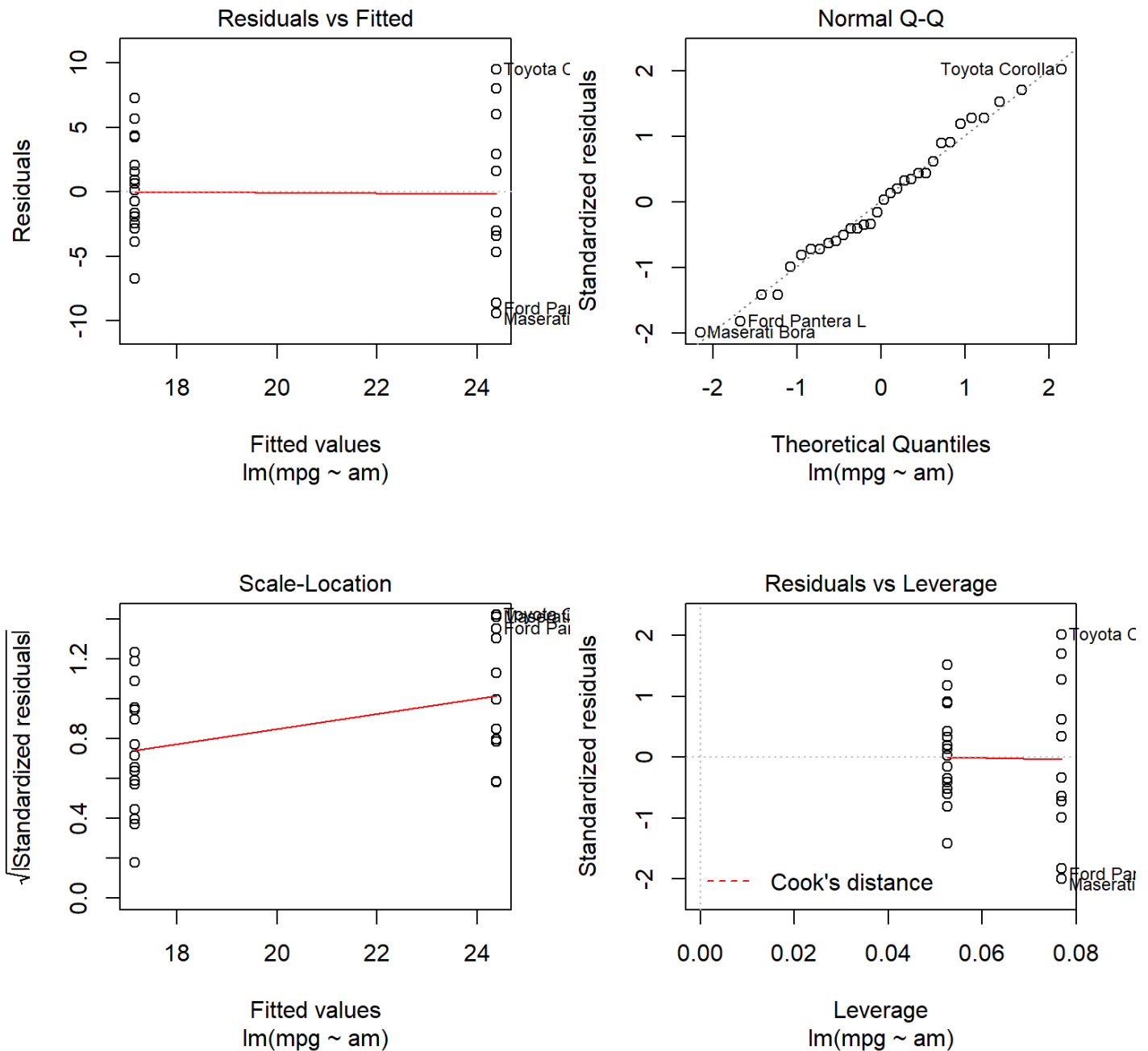

APPENDIX

Appendix 1.1

The data comes from Henderson and Velleman (1981), which extracted data 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). The variables in this data set include: Miles per gallon (mpg), Number of cylinders (cyl), Displacement cubic inch (disp), Gross horsepower (hp), Rear axle ratio (drat), Weight in 1000 lbs (wt), 1/4 mile time (qsec), Engine (vs; 0 = V-shaped, 1 = straight), Transmission (am; 0 = automatic, 1 = manual), Number of forward gears (gear), and Number of carburetors (carb). Data source: Henderson and Velleman (1981), Building multiple regression models interactively. Biometrics, 37, 391–411.

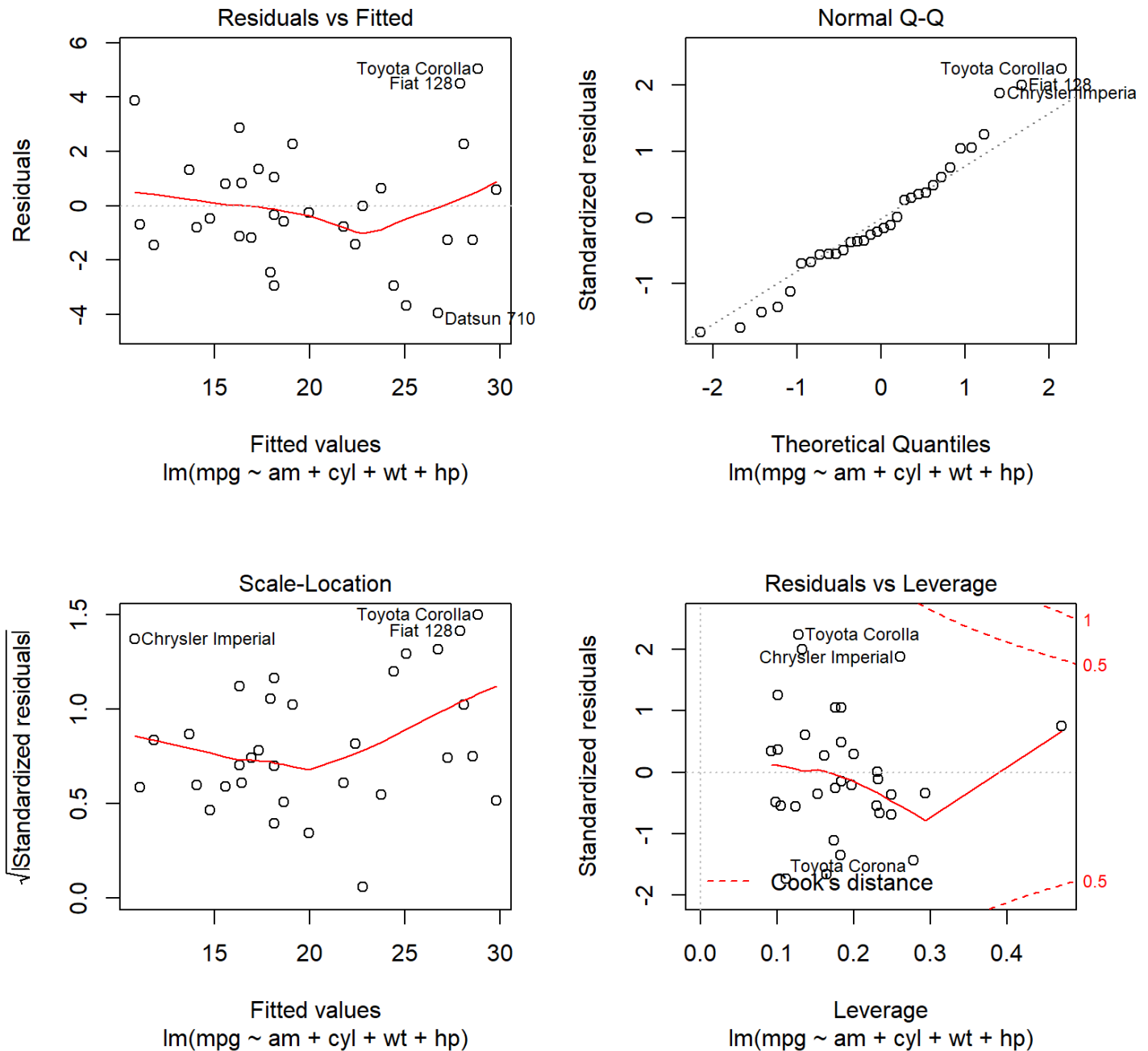Appendix 1.2: ANOVA and Residual Plots for Question 1

```
anova(model1, model2)
```

```
## Analysis of Variance Table
##
## Model 1: mpg ~ am
## Model 2: mpg ~ am + cyl + wt + hp
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1     30 720.90
## 2     26 151.03  4    569.87 24.527 1.688e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
plot(model1)
```

```
plot(model2)
```

Residuals vs Fitted

Fitted values
lm(mpg ~ am + cyl + wt + hp)

Normal Q-Q

Theoretical Quantiles
lm(mpg ~ am + cyl + wt + hp)

Scale-Location

Fitted values
lm(mpg ~ am + cyl + wt + hp)

Residuals vs Leverage

Leverage
lm(mpg ~ am + cyl + wt + hp)

Appendix 1.3: Descriptive data for the data set

```
kable(mtcars, caption="1974 Motor Trend Car Data") %>%
  kable_styling(bootstrap_options = "striped", full_width = F, position = "left")
```

1974 Motor Trend Car Data

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	mpg_z	mpg_type
Cadillac Fleetwood	10.4	8cyl	472.0	205	2.93	5.250	17.98	0	Automatic	3	4	-1.61	below

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	mpg_z	mpg_type
Lincoln Continental	10.4	8cyl	460.0	215	3.00	5.424	17.82	0	Automatic	3	4	-1.61	below
Camaro Z28	13.3	8cyl	350.0	245	3.73	3.840	15.41	0	Automatic	3	4	-1.13	below
Duster 360	14.3	8cyl	360.0	245	3.21	3.570	15.84	0	Automatic	3	4	-0.96	below
Chrysler Imperial	14.7	8cyl	440.0	230	3.23	5.345	17.42	0	Automatic	3	4	-0.89	below
Maserati Bora	15.0	8cyl	301.0	335	3.54	3.570	14.60	0	Manual	5	8	-0.84	below
Merc 450SLC	15.2	8cyl	275.8	180	3.07	3.780	18.00	0	Automatic	3	3	-0.81	below
AMC Javelin	15.2	8cyl	304.0	150	3.15	3.435	17.30	0	Automatic	3	2	-0.81	below
Dodge Challenger	15.5	8cyl	318.0	150	2.76	3.520	16.87	0	Automatic	3	2	-0.76	below
Ford Pantera L	15.8	8cyl	351.0	264	4.22	3.170	14.50	0	Manual	5	4	-0.71	below
Merc 450SE	16.4	8cyl	275.8	180	3.07	4.070	17.40	0	Automatic	3	3	-0.61	below
Merc 450SL	17.3	8cyl	275.8	180	3.07	3.730	17.60	0	Automatic	3	3	-0.46	below
Merc 280C	17.8	6cyl	167.6	123	3.92	3.440	18.90	1	Automatic	4	4	-0.38	below
Valiant	18.1	6cyl	225.0	105	2.76	3.460	20.22	1	Automatic	3	1	-0.33	below
Hornet Sportabout	18.7	8cyl	360.0	175	3.15	3.440	17.02	0	Automatic	3	2	-0.23	below
Merc 280	19.2	6cyl	167.6	123	3.92	3.440	18.30	1	Automatic	4	4	-0.15	below
Pontiac Firebird	19.2	8cyl	400.0	175	3.08	3.845	17.05	0	Automatic	3	2	-0.15	below
Ferrari Dino	19.7	6cyl	145.0	175	3.62	2.770	15.50	0	Manual	5	6	-0.06	below
Mazda RX4	21.0	6cyl	160.0	110	3.90	2.620	16.46	0	Manual	4	4	0.15	above
Mazda RX4 Wag	21.0	6cyl	160.0	110	3.90	2.875	17.02	0	Manual	4	4	0.15	above
Hornet 4 Drive	21.4	6cyl	258.0	110	3.08	3.215	19.44	1	Automatic	3	1	0.22	above
Volvo 142E	21.4	4cyl	121.0	109	4.11	2.780	18.60	1	Manual	4	2	0.22	above
Toyota Corona	21.5	4cyl	120.1	97	3.70	2.465	20.01	1	Automatic	3	1	0.23	above
Datsun 710	22.8	4cyl	108.0	93	3.85	2.320	18.61	1	Manual	4	1	0.45	above

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	mpg_z	mpg_type
Merc 230	22.8	4cyl	140.8	95	3.92	3.150	22.90	1	Automatic	4	2	0.45	above
Merc 240D	24.4	4cyl	146.7	62	3.69	3.190	20.00	1	Automatic	4	2	0.72	above
Porsche 914-2	26.0	4cyl	120.3	91	4.43	2.140	16.70	0	Manual	5	2	0.98	above
Fiat X1-9	27.3	4cyl	79.0	66	4.08	1.935	18.90	1	Manual	4	1	1.20	above
Honda Civic	30.4	4cyl	75.7	52	4.93	1.615	18.52	1	Manual	4	2	1.71	above
Lotus Europa	30.4	4cyl	95.1	113	3.77	1.513	16.90	1	Manual	5	2	1.71	above
Fiat 128	32.4	4cyl	78.7	66	4.08	2.200	19.47	1	Manual	4	1	2.04	above
Toyota Corolla	33.9	4cyl	71.1	65	4.22	1.835	19.90	1	Manual	4	1	2.29	above