Influence of Transmission Type on Vehicle Fuel Consumption - A foray into Regression Analysis

Output Summaries

Correlation

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
mpg	1.00	-0.85	-0.85	-0.78	0.68	-0.87	0.42	0.66	0.60	0.48	-0.55
cyl	-0.85	1.00	0.90	0.83	-0.70	0.78	-0.59	-0.81	-0.52	-0.49	0.53
disp	-0.85	0.90	1.00	0.79	-0.71	0.89	-0.43	-0.71	-0.59	-0.56	0.39
hp	-0.78	0.83	0.79	1.00	-0.45	0.66	-0.71	-0.72	-0.24	-0.13	0.75
drat	0.68	-0.70	-0.71	-0.45	1.00	-0.71	0.09	0.44	0.71	0.70	-0.09
wt	-0.87	0.78	0.89	0.66	-0.71	1.00	-0.17	-0.55	-0.69	-0.58	0.43
qsec	0.42	-0.59	-0.43	-0.71	0.09	-0.17	1.00	0.74	-0.23	-0.21	-0.66
vs	0.66	-0.81	-0.71	-0.72	0.44	-0.55	0.74	1.00	0.17	0.21	-0.57
am	0.60	-0.52	-0.59	-0.24	0.71	-0.69	-0.23	0.17	1.00	0.79	0.06
gear	0.48	-0.49	-0.56	-0.13	0.70	-0.58	-0.21	0.21	0.79	1.00	0.27
carb	-0.55	0.53	0.39	0.75	-0.09	0.43	-0.66	-0.57	0.06	0.27	1.00

(a) Table - Simple Correlation

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
mpg	1.00	-0.91	-0.91	-0.89	0.65	-0.89	0.47	0.71	0.56	0.54	-0.66
cyl	-0.91	1.00	0.93	0.90	-0.68	0.86	-0.57	-0.81	-0.52	-0.56	0.58
disp	-0.91	0.93	1.00	0.85	-0.68	0.90	-0.46	-0.72	-0.62	-0.59	0.54
hp	-0.89	0.90	0.85	1.00	-0.52	0.77	-0.67	-0.75	-0.36	-0.33	0.73
drat	0.65	-0.68	-0.68	-0.52	1.00	-0.75	0.09	0.45	0.69	0.74	-0.13
wt	-0.89	0.86	0.90	0.77	-0.75	1.00	-0.23	-0.59	-0.74	-0.68	0.50
qsec	0.47	-0.57	-0.46	-0.67	0.09	-0.23	1.00	0.79	-0.20	-0.15	-0.66
vs	0.71	-0.81	-0.72	-0.75	0.45	-0.59	0.79	1.00	0.17	0.28	-0.63
am	0.56	-0.52	-0.62	-0.36	0.69	-0.74	-0.20	0.17	1.00	0.81	-0.06
gear	0.54	-0.56	-0.59	-0.33	0.74	-0.68	-0.15	0.28	0.81	1.00	0.11
carb	-0.66	0.58	0.54	0.73	-0.13	0.50	-0.66	-0.63	-0.06	0.11	1.00

(b) Table - Pearson Correlation

Table 1: One-to-One Correllations

Modelling schemas

```
## Method 1
fitAll <- lm(mpg ~ ., data=mtcars)
fitAlla <- update(fitAll, mpg ~ . - qsec)
fitAllb <- update(fitAlla, mpg ~ . - qsec - carb)
fitAllc <- update(fitAllb, mpg ~ . - qsec - carb - gear)
fitAlld <- update(fitAllc, mpg ~ . - qsec - carb - gear - drat)
fitAlle <- update(fitAlld, mpg ~ . - qsec - carb - gear - drat - vs)
fitAllf <- update(fitAlle, mpg ~ . - qsec - carb - gear - drat - vs - cyl)
fitAllg <- update(fitAllf, mpg ~ . - qsec - carb - gear - drat - vs - cyl - disp)
fitAllh <- update(fitAllg, mpg ~ . - qsec - carb - gear - drat - vs - cyl - disp - hp)

meth1Anova <- anova(fitAll, fitAlla, fitAllb, fitAllc, fitAlld, fitAlle, fitAllf, fitAllg, fitAllh)

library(xtable)

print(xtable(summary(fitAll)), file="tall.tex", floating=FALSE)
print(xtable(summary(fitAlla)$coef), file="talla.tex", floating=FALSE)
print(xtable(summary(fitAllb)$coef), file="tallb.tex", floating=FALSE)
print(xtable(summary(fitAllc)$coef), file="tallc.tex", floating=FALSE)
print(xtable(summary(fitAlld)$coef), file="talld.tex", floating=FALSE)
print(xtable(summary(fitAlle)$coef), file="talle.tex", floating=FALSE)
print(xtable(summary(fitAllf)$coef), file="tallf.tex", floating=FALSE)
print(xtable(summary(fitAllg)$coef), file="tallg.tex", floating=FALSE)

meth1Anova


## Analysis of Variance Table
##
## Model 1: mpg ~ cyl + disp + hp + drat + wt + qsec + vs + am + gear + carb
```

```
## Model 2: mpg ~ cyl + disp + hp + drat + wt + vs + am + gear + carb
## Model 3: mpg ~ cyl + disp + hp + drat + wt + vs + am + gear
## Model 4: mpg ~ cyl + disp + hp + drat + wt + vs + am
## Model 5: mpg ~ cyl + disp + hp + wt + vs + am
## Model 6: mpg ~ cyl + disp + hp + wt + am
## Model 7: mpg ~ disp + hp + wt + am
## Model 8: mpg ~ hp + wt + am
## Model 9: mpg ~ wt + am
##   Res.Df RSS Df Sum of Sq      F Pr(>F)
## 1     21 148
## 2     22 156 -1      -8.9  1.26 0.2739
## 3     23 159 -1      -2.2  0.32 0.5793
## 4     24 159 -1      -0.1  0.01 0.9223
## 5     25 160 -1      -0.9  0.12 0.7288
## 6     26 163 -1      -3.6  0.51 0.4820
## 7     27 180 -1     -16.8  2.39 0.1370
## 8     28 180 -1      -0.4  0.05 0.8175
## 9     29 278 -1     -98.0 13.96 0.0012 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	12.3034	18.7179	0.66	0.5181
cyl	-0.1114	1.0450	-0.11	0.9161
disp	0.0133	0.0179	0.75	0.4635
hp	-0.0215	0.0218	-0.99	0.3350
drat	0.7871	1.6354	0.48	0.6353
wt	-3.7153	1.8944	-1.96	0.0633
qsec	0.8210	0.7308	1.12	0.2739
vs	0.3178	2.1045	0.15	0.8814
am	2.5202	2.0567	1.23	0.2340
gear	0.6554	1.4933	0.44	0.6652
carb	-0.1994	0.8288	-0.24	0.8122

(a) Table - All

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	28.51	11.99	2.38	0.03
cyl	-0.43	1.01	-0.43	0.67
disp	0.01	0.02	0.44	0.66
hp	-0.02	0.02	-1.11	0.28
drat	0.72	1.64	0.44	0.67
wt	-2.64	1.64	-1.60	0.12
vs	1.18	1.97	0.60	0.56
am	1.89	1.99	0.95	0.35
gear	0.52	1.50	0.35	0.73
carb	-0.45	0.80	-0.56	0.58

(b) Table - a

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	32.06	10.03	3.20	0.00
cyl	-0.62	0.94	-0.66	0.52
disp	0.01	0.01	1.07	0.29
hp	-0.03	0.02	-1.79	0.09
drat	0.51	1.58	0.33	0.75
wt	-3.26	1.20	-2.72	0.01
vs	1.42	1.90	0.75	0.46
am	1.87	1.96	0.96	0.35
gear	0.13	1.31	0.10	0.92

(c) Table - b

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	32.46	9.02	3.60	0.00
cyl	-0.64	0.90	-0.71	0.48
disp	0.01	0.01	1.11	0.28
hp	-0.03	0.01	-2.06	0.05
drat	0.55	1.51	0.36	0.72
wt	-3.25	1.17	-2.78	0.01
vs	1.40	1.85	0.76	0.46
am	1.95	1.76	1.11	0.28

(d) Table - c

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	34.97	5.68	6.16	0.00
cyl	-0.73	0.84	-0.87	0.39
disp	0.01	0.01	1.11	0.28
hp	-0.03	0.01	-2.07	0.05
wt	-3.28	1.14	-2.87	0.01
vs	1.36	1.81	0.75	0.46
am	2.14	1.65	1.30	0.21

(e) Table - d

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	38.20	3.67	10.41	0.00
cyl	-1.11	0.68	-1.64	0.11
disp	0.01	0.01	1.05	0.30
hp	-0.03	0.01	-2.01	0.06
wt	-3.30	1.13	-2.91	0.01
am	1.56	1.44	1.08	0.29

(f) Table - e

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	34.21	2.82	12.12	0.00
disp	0.00	0.01	0.24	0.81
hp	-0.04	0.01	-3.16	0.00
wt	-3.05	1.16	-2.63	0.01
am	2.16	1.44	1.50	0.14

(g) Table - f

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	34.00	2.64	12.87	0.00
hp	-0.04	0.01	-3.90	0.00
wt	-2.88	0.90	-3.18	0.00
am	2.08	1.38	1.51	0.14

(h) Table - g

Table 2: Step wise - back

```
## Method 2
fit1 <- lm(mpg ~ am:wt, mtcars)
fit1a <- update(fit1, mpg ~ am:wt + hp)
fit1b <- update(fit1a, mpg ~ am:wt + hp*cyl)
fit1c <- update(fit1b, mpg ~ am:wt + hp*cyl*disp)
fit1d <- update(fit1c, mpg ~ am:wt + hp*cyl*disp*drat)

meth2Anova <- anova(fit1, fit1a, fit1b, fit1c, fit1d)

library(xtable)
```

```r
print(xtable(summary(fit1)), file="t1.tex", floating=FALSE)
print(xtable(summary(fit1a)$coef), file="t1a.tex", floating=FALSE)
print(xtable(summary(fit1b)$coef), file="t1b.tex", floating=FALSE)
print(xtable(summary(fit1c)$coef), file="t1c.tex", floating=FALSE)
print(xtable(summary(fit1d)$coef), file="t1d.tex", floating=FALSE)
```

meth2Anova

```
## Analysis of Variance Table
##
## Model 1: mpg ~ am:wt
## Model 2: mpg ~ hp + am:wt
## Model 3: mpg ~ hp + cyl + am:wt + hp:cyl
## Model 4: mpg ~ hp + cyl + disp + am:wt + hp:cyl + hp:disp + cyl:disp +
##     hp:cyl:disp
## Model 5: mpg ~ hp + cyl + disp + drat + am:wt + hp:cyl + hp:disp + cyl:disp +
##     hp:drat + cyl:drat + disp:drat + hp:cyl:disp + hp:cyl:drat +
##     hp:disp:drat + cyl:disp:drat + hp:cyl:disp:drat
##   Res.Df RSS Df Sum of Sq      F  Pr(>F)
## 1     30 950
## 2     29 300  1       650 120.95 1.4e-08 ***
## 3     27 209  2        91   8.46  0.0035 **
## 4     23 148  4        61   2.82  0.0628 .
## 5     15  81  8        67   1.56  0.2169
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	18.2415	1.2664	14.40	0.0000
am:wt	1.8879	0.8003	2.36	0.0250

(a) Table - All

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	28.20	1.45	19.46	0.00
hp	-0.07	0.01	-7.93	0.00
am:wt	1.73	0.46	3.79	0.00

(b) Table - a

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	47.53	6.25	7.60	0.00
hp	-0.19	0.07	-2.94	0.01
cyl	-3.36	0.98	-3.42	0.00
am:wt	1.10	0.49	2.25	0.03
hp:cyl	0.02	0.01	2.47	0.02

(c) Table - b

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	91.11	27.15	3.36	0.00
hp	-0.47	0.26	-1.81	0.08
cyl	-10.70	4.94	-2.16	0.04
disp	-0.36	0.20	-1.84	0.08
am:wt	0.51	0.53	0.96	0.35
hp:cyl	0.07	0.04	1.76	0.09
hp:disp	0.00	0.00	1.28	0.21
cyl:disp	0.05	0.03	1.83	0.08
hp:cyl:disp	-0.00	0.00	-1.36	0.19

(d) Table - c

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1078.26	443.78	2.43	0.03
hp	-9.38	3.95	-2.38	0.03
cyl	-209.69	80.63	-2.60	0.02
disp	-6.83	4.24	-1.61	0.13
drat	-284.72	124.76	-2.28	0.04
am:wt	-0.03	0.72	-0.04	0.97
hp:cyl	1.60	0.61	2.63	0.02
hp:disp	0.08	0.04	1.84	0.09
cyl:disp	1.08	0.58	1.85	0.08
hp:drat	2.62	1.12	2.34	0.03
cyl:drat	56.89	23.01	2.47	0.03
disp:drat	1.85	1.17	1.58	0.13
hp:cyl:disp	-0.01	0.01	-2.00	0.06
hp:cyl:drat	-0.45	0.17	-2.56	0.02
hp:disp:drat	-0.02	0.01	-1.84	0.09
cyl:disp:drat	-0.29	0.16	-1.80	0.09
hp:cyl:disp:drat	0.00	0.00	1.98	0.07

(e) Table - d

Table 3: Interactions

```r
## Method 3
fit2 <- lm(mpg ~ am + wt, mtcars)
fit2a <- update(fit2, mpg ~ am + wt + hp)
fit2b <- update(fit2a, mpg ~ am:wt + hp)
```

```
meth3Anova <- anova(fit2, fit2a, fit2b)

library(xtable)

print(xtable(summary(fit2)), file="t2.tex", floating=FALSE)
print(xtable(summary(fit2a)$coef), file="t2a.tex", floating=FALSE)
print(xtable(summary(fit2b)$coef), file="t2b.tex", floating=FALSE)


meth3Anova


## Analysis of Variance Table
##
## Model 1: mpg ~ am + wt
## Model 2: mpg ~ am + wt + hp
## Model 3: mpg ~ hp + am:wt
##   Res.Df RSS Df Sum of Sq    F  Pr(>F)
## 1     29 278
## 2     28 180  1       98 15.2 0.00055 ***
## 3     29 300 -1     -119 18.5 0.00019 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	37.3216	3.0546	12.22	0.0000
am	-0.0236	1.5456	-0.02	0.9879
wt	-5.3528	0.7882	-6.79	0.0000

(a) Table - a

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	34.00	2.64	12.87	0.00
am	2.08	1.38	1.51	0.14
wt	-2.88	0.90	-3.18	0.00
hp	-0.04	0.01	-3.90	0.00

(b) Table - b

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	28.20	1.45	19.46	0.00
hp	-0.07	0.01	-7.93	0.00
am:wt	1.73	0.46	3.79	0.00

(c) Table - c

Table 4: weight