STAT 350

Assignment 3: Solutions

The data and assignment comments are here.

1. Problem 8.6 parts a, b, e and f.

   Solutions:

   Part a: Here is R *code to fit the quadratic model and plot the data and the fitted quadratic:*

```
 d = read.table('8.6.dat',header=T)
 attach(d)
#
# Centre the independent variable as in 8.1
#
 x=Age-mean(Age)
 x2=x^2
#
# Fit the quadratic model
#
 fit.a=lm(Steroid~x+x2)
 fit.a

Call:
lm(formula = Steroid ~ x + x2)

Coefficients:
(Intercept)            x           x2
    21.0942       1.1374      -0.1184
#
# Create a vector of 200 values spread
#  out over the range of x
#
 u = seq(min(x),max(x),length=200)
#
#  Compute the fitted value for each value of u
#
 muhat = 21.0942 + 1.1374*u-0.1184*u^2
#
#  Plot the fitted value against age, not u
#
 xp = u+mean(Age)
 postscript("DataPlusFit.ps",height=4.0,width=6.5)
```

```
plot(Age,Steroid,xlab="Age (years)",ylab="Steroid Level")
lines(xp,muhat)
dev.off()
```

The fit looks quite ok. The code

```
summary(fit.a)
```

produces R^2 *among many other things. Output:*

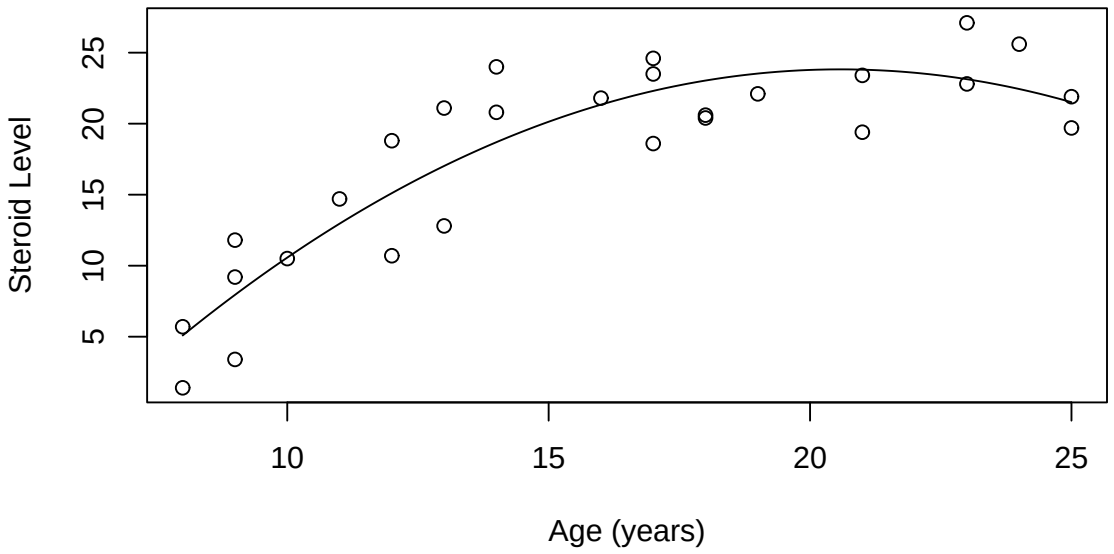
```
Call:
lm(formula = Steroid ~ x + x2)

Residuals:
    Min      1Q  Median      3Q     Max
-4.5463 -2.5369  0.3868  2.1973  5.3020

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 21.09416    0.91415  23.075  < 2e-16 ***
x            1.13736    0.11546   9.851 6.59e-10 ***
x2          -0.11840    0.02347  -5.045 3.71e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.153 on 24 degrees of freedom
Multiple R-Squared: 0.8143,     Adjusted R-squared: 0.7989
F-statistic: 52.63 on 2 and 24 DF,  p-value: 1.678e-09
```

We get $R^2 = 0.81$. *The fit looks good to the eye:*



Part b: The model is

$$y = \beta_0 + \beta_1 x + \beta_{11} x^2 + \epsilon$$

in the book's notation. We test $H_o : \beta_1 = \beta_{11} = 0$ *from the overall* F *statistic* $F = 52.63$*. There are 27 data points and 3 parameters so the error sum of squares has 24 degrees of freedom. The model sum of squares has 2 degrees of freedom since there are 2 parameters other than the intercept. The associated* P*-value is* 1.7×10^{-9} *which provides overwhelming evidence that there is a non-zero regression relationship. Your answer should mention, as the book asks, that the null hypothesis is rejected; the* P*-value is below 0.01.*

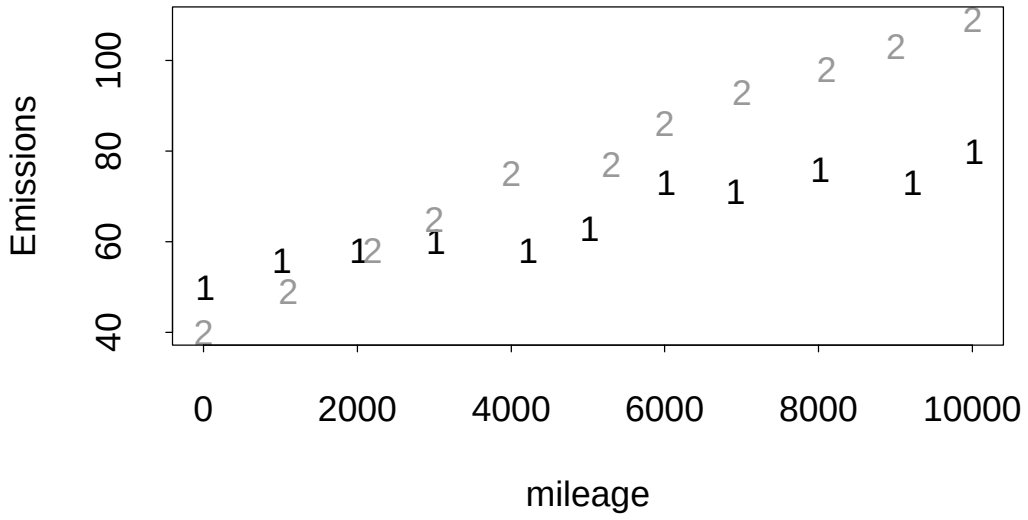
Part e: To see if $\beta_{11} = 0$ *you may use a two sided* t*-test. The test statistic is* $t = -5.045$*. There are 24 degrees of freedom. The* P *value for the two sided test is* 3.7×10^{-5} *so the quadratic term clearly cannot be dropped from the model.*

Part f: We have $x = Age - \overline{Age} = Age - 15.7778$*. So*

$$\begin{aligned}
\hat{\mu} &= 21.0942 + 1.1374x - 0.1184x^2 \\
&= 21.0942 + 1.1372(Age - 15.7778) - 0.1184(Age - 15.7778)^2 \\
&= -26.3234 + 4.7834 Age - 0.1184 Age^2
\end{aligned}$$

2. Vehicle mileage vs emissions.

   (a) Plot the data.



(b) Consider the following 4 models for the data:

i. Two straight lines, one for each vehicle, with different slopes and intercepts,
ii. Two parallel straight lines.
iii. Two lines with the same intercept but different slopes.
iv. One straight line.

Write out model equations for data points number 2 and 22 for the first 3 models.
Solution: *FIRST MODEL*

$$Y_2 = \beta_1 + 1000\beta_2 + \epsilon_2$$

and

$$Y_{22} = \beta_3 + 10000\beta_4 + \epsilon_{22}\,.$$

Here β_1 and β_3 are the two intercepts while β_2 and β_4 are the slopes.
SECOND MODEL

$$Y_2 = \beta_1 + 1000\beta_2 + \epsilon_2$$

and

$$Y_{22} = \beta_3 + 10000\beta_2 + \epsilon_{22}\,.$$

Here β_1 and β_3 are the two intercepts while β_2 is the common slope.
THIRD MODEL

$$Y_2 = \beta_1 + 1000\beta_2 + \epsilon_2$$

and

$$Y_{22} = \beta_1 + 10000\beta_4 + \epsilon_{22}\,.$$

Here β_2 and β_4 are the two slopes while β_1 is the common intercept.
FOURTH MODEL

$$Y_2 = \beta_1 + 1000\beta_2 + \epsilon_2$$

and

$$Y_{22} = \beta_1 + 10000\beta_2 + \epsilon_{22}\,.$$

Here β_2 is the common slope and β_1 is the common intercept.

(c) Fit all 4 models. Hand in: estimates of the slopes and intercepts and of σ. Do NOT just hand in output from SAS or Minitab.
Solution: *I create a data file which contains the design matrix for the first model.*

```
 50 1     0        0     0
 56 1  1000        0     0
 58 1  2000        0     0
 60 1  3000        0     0
 58 1  4200        0     0
 63 1  5000        0     0
 73 1  6000        0     0
 71 1  6900        0     0
 76 1  8000        0     0
 73 1  9200        0     0
 80 1 10000        0     0
 40 0     0        1     0
 49 0     0        1  1100
 58 0     0        1  2200
 65 0     0        1  3000
 75 0     0        1  4000
 77 0     0        1  5300
 86 0     0        1  6000
 93 0     0        1  7000
 98 0     0        1  8100
103 0     0        1  9000
109 0     0        1 10000
```

I used the following SAS code to fit the models.

```
options pagesize=60 linesize=80;
data mileage;
  infile 'mile1.dat' ;
  input emiss car1 mile1 car2 mile2 ;
  mile = mile1+mile2;
proc glm  data=mileage;
   model emiss =  car1 mile1 car2 mile2 / NOINT ;
```

```
   estimate 'sloped' mile1 1 mile2 -1 /E ;
   estimate 'intd' car1 1 car2 -1 /E ;
run ;
proc glm  data=mileage;
   model emiss =  car1 car2 mile /NOINT  ;
run ;
proc glm  data=mileage;
   model emiss =  mile1 mile2  ;
run ;
proc glm  data=mileage;
   model emiss =  mile ;
run ;
proc glm  data=mileage;
   model emiss =  car1 mile1 car2 mile2 / NOINT ;
   estimate 'veh1em' car1 10000 mile1 50000000 /E ;
   estimate 'veh2em' car2 10000 mile2 50000000 /E ;
   estimate 'diff'   car1 10000 mile1 50000000
         car2 -10000 mile2 -50000000 /E;
run ;
```

Here are the estimates;

Model	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$\hat{\sigma}$
1	*51.28*	*0.00278*	*42.93*	*0.00684*	*2.79*
2	*41.20*	*0.00479*	*53.29*	—	*7.41*
3	*47.16*	*0.00337*	—	*0.00623*	*3.62*
4	*47.19*	*0.00480*	—	—	*9.61*

(d) Using formal hypothesis tests and plots select the best of these models. Again, I do not want computer output but discussion. You may attach computer output in order to say things like: "The Sum of Squares for ... is on page ..." and to hand in plots on which you comment in the discussion but I will not be looking through the output.

Solution: *I begin by testing the hypothesis that $\beta_2 = \beta_4$. You can do this either using the extra sum of squares F-test or a suitable t-test. The line* `estimate 'sloped'` *gets standard errors and a t-statistic. The output lines corresponding to the estimate lines is*

```
                      T for H0: Pr > |T| Std Error of
Parameter  Estimate Parameter=0             Estimate

sloped  -0.00405367    -10.75     0.0001   0.00037706
intd     8.35473800      3.72     0.0016   2.24468995
```

Each of these tests is quite significant so that you can't get by with either a common slope or a common intercept. That is, the first model is preferred. You can also

do extra sum of squares tests. The needed information is in the Error SS from the various runs of `glm`*:*

```
MODEL      Error DF      Error SS          MSE
1            18         140.47791         7.80433
2            19        1042.46491        54.86657
3            19         248.59354        13.0838705
4            20        1847.50378        92.3751888
```

The extra SS F-statistic for testing model 2 against model 1 is $[(1042.46-140.48)/1]/[140.48/18]$ *and this is compared to F tables with 1 and 18 degrees of freedom. The statistic value is 115.6 which is very significant. Similarly model 3 is rejected in favour of model 1. Model 4, requiring both models 2 and 3 to be correct is untenable. It can be tested directly against model 1 using* $[(1847.50378 - 140.477910/2]/7.80433$ *as an F-test.*

(e) For the final selected model estimate the total emissions of CO in grams for each vehicle over the first 10000 miles. (This is the area under the fitted straight line from 0 to 10000 and is a linear combination of the parameter estimates.) Attach a standard error.

Solution: *In terms of the coefficients in the model the emissions for vehicle1 are* $10,000\beta_1 + 50,000,000\beta_2$ *while those for vehicle 2 are* $10,000\beta_3 + 50,000,000\beta_4$*. These are estimated by plugging in least squares estimates. These two estimates and their difference are all linear combinations of the form $a^T\hat{\beta}$ for which the standard error is $\sigma\sqrt{a^t(X^TX)^{-1}a}$. You can calculate these standard errors using* `estimate` *statements as in the last run of* `proc glm`*. The corresponding output is*

```
                      T for H0:  Pr > |T| Std Error of
Parameter    Estimate Parameter=0             Estimate

veh1em     651968.435       77.40   0.0001    8423.4004
veh2em     771104.319       91.53   0.0001    8424.8153
diff      -119135.884      -10.00   0.0001   11913.4876
```

The last line shows that the two cars have different emissions in total over the first 10000 miles (answering the next part) while the previous 2 permit confidence intervals of the form $651968 \pm t_{18,0.025}8423$*.*

(f) Are the emissions of the two vehicles different over the first 10000 miles?

Solution: *The answer is yes, the second vehicle clearly has higher emissions. See the previous question for the test.*

3. Data below are from a nitrogen balance experiment on Kangaroo Island Wallabies, taken from Barker,S. (1968). "Nitrogen balance and Water Intake in the Kangaroo Island Wallaby" *Austral. J. Experimental Biology and Medical Science*, **46**, 17-32.

Y Nitrogen Excreted	X_1 Body Weight	X_2 Dry Intake	X_3 Water Intake	X_4 Nitrogen Intake
162	3.386	16.6	41.7	54
174	3.033	18.1	40.9	99
119	3.477	13.4	25.0	46
205	3.278	22.6	39.2	188
312	3.368	26.5	47.4	345
157	2.932	21.4	51.6	66
184	3.128	30.3	71.6	171
155	3.251	17.6	27.1	81
192	3.396	21.3	37.7	175
331	3.497	29.9	50.5	399
114	3.182	12.8	28.4	38
159	3.234	19.6	34.3	106
260	3.139	36.2	77.6	228
265	3.434	35.0	58.9	291
387	2.970	32.9	55.3	449
146	3.230	22.9	46.2	72
233	3.470	32.9	67.4	176
261	3.000	35.7	77.1	235
287	3.224	34.4	74.9	288
412	3.366	36.2	60.7	485
174	3.264	29.9	65.4	92
171	3.292	21.7	51.2	126
259	3.525	35.0	66.8	224
298	3.036	29.7	65.8	276
407	3.356	29.2	48.1	386

Fit the model

$$E(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

by least squares. Get estimates and standard errors for all the parameters and an estimate of σ. Suggest a simpler model for the data, and fit it. Check the fit of the model, graphically and, if the model seems poor, modify it appropriately. Hand in a discussion of your findings bolstered by output used only as an appendix. Lihui will be marking the discussion, not sorting through the output.

Solution: *The final fitted model has X_4 only. An extra sum of squares F-test comparing this test to the full model accepts the null hypothesis that $\beta_1 = \beta_2 = \beta_3 = 0$.*

Here is SAS CODE

```
options pagesize=60 linesize=80;
data nit;
  infile 'nit.dat' ;
```

```
  input nitexc weight dryin wetin nitin ;
proc glm  data=nit;
   model nitexc = weight dryin wetin nitin ;
   output out=outdat rstudent=rstudent ;
run ;
proc print data=outdat;
proc glm  data=nit;
   model nitexc = dryin wetin nitin ;
run ;
proc glm  data=nit;
   model nitexc = weight wetin nitin ;
run ;
proc glm  data=nit;
   model nitexc = weight dryin nitin ;
run ;
proc glm  data=nit;
   model nitexc = weight dryin wetin ;
run ;
proc glm  data=nit;
   model nitexc = weight dryin ;
run ;
proc glm  data=nit;
   model nitexc = weight wetin ;
run ;
proc glm  data=nit;
   model nitexc = weight nitin ;
run ;
proc glm  data=nit;
   model nitexc = dryin wetin ;
run ;
proc glm  data=nit;
   model nitexc = dryin nitin ;
run ;
proc glm  data=nit;
   model nitexc = wetin nitin ;
run ;
proc glm  data=nit;
   model nitexc = weight ;
run ;
proc glm  data=nit;
   model nitexc = dryin ;
run ;
proc glm  data=nit;
   model nitexc = wetin ;
```

```
run ;
proc glm  data=nit;
   model nitexc = nitin ;
run ;
data nited;
  infile 'nited.dat' ;
  input nitexc weight dryin wetin nitin ;
proc glm  data=nited;
   model nitexc = weight dryin wetin nitin ;
run;
proc glm  data=nited;
   model nitexc = wetin nitin ;
run;
```

OUTPUT:

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	176545.15438	44136.28859	104.32	0.0001
Error	20	8461.80562	423.09028		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.954262	8.829481	20.569158	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.277585	906.277585	2.14	0.1589
DRYIN	1	98226.180512	98226.180512	232.16	0.0001
WETIN	1	34985.289580	34985.289580	82.69	0.0001
NITIN	1	42427.406699	42427.406699	100.28	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F

WEIGHT	1	18.961955	18.961955	0.04	0.8345
DRYIN	1	26.332244	26.332244	0.06	0.8055
WETIN	1	117.344991	117.344991	0.28	0.6042
NITIN	1	42427.406699	42427.406699	100.28	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	111.0250320	1.21	0.2421	92.09694447
WEIGHT	-0.0059440	-0.21	0.8345	0.02807714
DRYIN	-0.0600051	-0.25	0.8055	0.24052534
WETIN	0.0478373	0.53	0.6042	0.09083460
NITIN	0.6480928	10.01	0.0001	0.06471880

OBS	NITEXC	WEIGHT	DRYIN	WETIN	NITIN	RSTUDENT
1	162	3386	166	417	54	1.54293
2	174	3033	181	409	99	0.42358
3	119	3477	134	250	46	-0.27592
4	205	3278	226	392	188	-0.68195
5	312	3368	265	474	345	-0.49070
6	157	2932	214	516	66	0.47392
7	184	3128	303	716	171	-2.02733
8	155	3251	176	271	81	0.46906
9	192	3396	213	377	175	-0.88876
10	331	3497	299	505	399	-1.36433
11	114	3182	128	284	38	-0.45622
12	159	3234	196	343	106	-0.31704
13	260	3139	362	776	228	0.23271
14	265	3434	350	589	291	-1.22320
15	387	2970	329	553	449	-0.25303
16	146	3230	229	462	72	-0.04293
17	233	3470	329	674	176	0.87203
18	261	3000	357	771	235	0.00238
19	287	3224	344	749	288	-0.34905
20	412	3366	362	607	485	-0.03575
21	174	3264	299	654	92	0.49320
22	171	3292	217	512	126	-0.71362
23	259	3525	350	668	224	0.71204
24	298	3036	297	658	276	0.66482
25	407	3356	292	481	386	4.45054

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	176526.19242	58842.06414	145.70	0.0001
Error	21	8480.76758	403.84608		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.954160	8.626340	20.095922	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
DRYIN	1	98370.974292	98370.974292	243.59	0.0001
WETIN	1	32270.829043	32270.829043	79.91	0.0001
NITIN	1	45884.389086	45884.389086	113.62	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DRYIN	1	60.464019	60.464019	0.15	0.7027
WETIN	1	220.186413	220.186413	0.55	0.4684
NITIN	1	45884.389086	45884.389086	113.62	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	91.84916426	5.65	0.0001	16.26623043
DRYIN	-0.08200363	-0.39	0.7027	0.21193002
WETIN	0.05721277	0.74	0.4684	0.07748286
NITIN	0.65159457	10.66	0.0001	0.06112979

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	176518.82213	58839.60738	145.57	0.0001
Error	21	8488.13787	404.19704		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.954120	8.630088	20.104652	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.27759	906.27759	2.24	0.1492
WETIN	1	42861.23673	42861.23673	106.04	0.0001
NITIN	1	132751.30782	132751.30782	328.43	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	53.09373	53.09373	0.13	0.7207
WETIN	1	322.23543	322.23543	0.80	0.3820
NITIN	1	132751.30782	132751.30782	328.43	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	118.9418333	1.41	0.1739	84.50456601
WEIGHT	-0.0089701	-0.36	0.7207	0.02474989
WETIN	0.0264778	0.89	0.3820	0.02965458
NITIN	0.6346470	18.12	0.0001	0.03501945

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

	Sum of	Mean

Source	DF	Squares	Square	F Value	Pr > F
Model	3	176427.80939	58809.26980	143.95	0.0001
Error	21	8579.15061	408.53098		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.953628	8.676232	20.212149	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.277585	906.277585	2.22	0.1512
DRYIN	1	98226.180512	98226.180512	240.44	0.0001
NITIN	1	77295.351288	77295.351288	189.20	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	121.803377	121.803377	0.30	0.5908
DRYIN	1	231.222686	231.222686	0.57	0.4602
NITIN	1	77295.351288	77295.351288	189.20	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	132.8604627	1.64	0.1150	80.80880973
WEIGHT	-0.0131531	-0.55	0.5908	0.02408862
DRYIN	0.0593909	0.75	0.4602	0.07894366
NITIN	0.6242147	13.76	0.0001	0.04538056

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	134117.74768	44705.91589	18.45	0.0001

Error	21	50889.21232	2423.29582	
Corrected Total	24	185006.96000		

R-Square	C.V.	Root MSE	NITEXC Mean
0.724934	21.13109	49.226983	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.277585	906.277585	0.37	0.5474
DRYIN	1	98226.180512	98226.180512	40.53	0.0001
WETIN	1	34985.289580	34985.289580	14.44	0.0010

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	3475.944343	3475.944343	1.43	0.2444
DRYIN	1	90350.233364	90350.233364	37.28	0.0001
WETIN	1	34985.289580	34985.289580	14.44	0.0010

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	280.4408594	1.29	0.2096	216.6595739
WEIGHT	-0.0778043	-1.20	0.2444	0.0649637
DRYIN	1.9458430	6.11	0.0001	0.3186738
WETIN	-0.5894146	-3.80	0.0010	0.1551248

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	99132.458098	49566.229049	12.70	0.0002
Error	22	85874.501902	3903.386450		
Corrected Total	24	185006.960000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.535831	26.81880	62.477087	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.277585	906.277585	0.23	0.6347
DRYIN	1	98226.180512	98226.180512	25.16	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	761.483806	761.483806	0.20	0.6630
DRYIN	1	98226.180512	98226.180512	25.16	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-96.88086530	-0.40	0.6956	244.3916997
WEIGHT	0.03257274	0.44	0.6630	0.0737471
DRYIN	0.84502653	5.02	0.0001	0.1684525

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	43767.514315	21883.757157	3.41	0.0513
Error	22	141239.445685	6419.974804		
Corrected Total	24	185006.960000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.236572	34.39421	80.124745	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F

WEIGHT	1	906.277585	906.277585	0.14	0.7107
WETIN	1	42861.236729	42861.236729	6.68	0.0169

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	4942.361995	4942.361995	0.77	0.3897
WETIN	1	42861.236729	42861.236729	6.68	0.0169

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	-185.3258157	-0.56	0.5801	330.0691617
WEIGHT	0.0846396	0.88	0.3897	0.0964657
WETIN	0.2717215	2.58	0.0169	0.1051619

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	176196.58670	88098.29335	219.99	0.0001
Error	22	8810.37330	400.47151		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.952378	8.590223	20.011784	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	906.27759	906.27759	2.26	0.1467
NITIN	1	175290.30911	175290.30911	437.71	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	156.93565	156.93565	0.39	0.5378
NITIN	1	175290.30911	175290.30911	437.71	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	149.1206302	1.93	0.0660	77.09291434
WEIGHT	-0.0148634	-0.63	0.5378	0.02374338
NITIN	0.6489156	20.92	0.0001	0.03101666

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	130641.80334	65320.90167	26.43	0.0001
Error	22	54365.15666	2471.14348		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.706145	21.33868	49.710597	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
DRYIN	1	98370.974292	98370.974292	39.81	0.0001
WETIN	1	32270.829043	32270.829043	13.06	0.0015

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DRYIN	1	91816.651016	91816.651016	37.16	0.0001
WETIN	1	32270.829043	32270.829043	13.06	0.0015

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	24.71409687	0.67	0.5122	37.09850642
DRYIN	1.78954584	6.10	0.0001	0.29358312

WETIN	-0.50633711	-3.61	0.0015	0.14011469

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	176306.00601	88153.00300	222.89	0.0001
Error	22	8700.95399	395.49791		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.952970	8.536714	19.887129	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
DRYIN	1	98370.974292	98370.974292	248.73	0.0001
NITIN	1	77935.031717	77935.031717	197.06	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DRYIN	1	266.354954	266.354954	0.67	0.4206
NITIN	1	77935.031717	77935.031717	197.06	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	89.61827486	5.67	0.0001	15.81712065
DRYIN	0.06345890	0.82	0.4206	0.07732755
NITIN	0.62079516	14.04	0.0001	0.04422360

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	176465.72840	88232.86420	227.27	0.0001
Error	22	8541.23160	388.23780		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.953833	8.457997	19.703751	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WETIN	1	38825.15232	38825.15232	100.00	0.0001
NITIN	1	137640.57608	137640.57608	354.53	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WETIN	1	426.07735	426.07735	1.10	0.3062
NITIN	1	137640.57608	137640.57608	354.53	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	88.74785286	6.39	0.0001	13.87826796
WETIN	0.02934402	1.05	0.3062	0.02801072
NITIN	0.63199810	18.83	0.0001	0.03356537

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	906.27758547	906.27758547	0.11	0.7396
Error	23	184100.6824145	8004.37749628		

```
Corrected Total          24    185006.9600000

                   R-Square             C.V.        Root MSE          NITEXC Mean

                   0.004899         38.40453       89.467187            232.96000


Source                   DF        Type I SS     Mean Square   F Value     Pr > F

WEIGHT                    1     906.27758547    906.27758547      0.11     0.7396

Source                   DF      Type III SS     Mean Square   F Value     Pr > F

WEIGHT                    1     906.27758547    906.27758547      0.11     0.7396


                                                T for H0:    Pr > |T|   Std Error of
Parameter                       Estimate    Parameter=0                    Estimate

INTERCEPT                  117.1655552           0.34      0.7369     344.5935770
WEIGHT                       0.0355337           0.34      0.7396       0.1056024

                      General Linear Models Procedure

                  Number of observations in data set = 25

Dependent Variable: NITEXC
                                      Sum of           Mean
Source                   DF          Squares         Square   F Value     Pr > F

Model                     1     98370.974292    98370.974292     26.12     0.0001

Error                    23     86635.985708     3766.781987

Corrected Total          24    185006.960000

                   R-Square             C.V.        Root MSE          NITEXC Mean

                   0.531715         26.34534       61.374115            232.96000


Source                   DF        Type I SS     Mean Square   F Value     Pr > F
```

DRYIN	1	98370.974292	98370.974292	26.12	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DRYIN	1	98370.974292	98370.974292	26.12	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	9.106935499	0.20	0.8431	45.49143652
DRYIN	0.845622033	5.11	0.0001	0.16547334

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	38825.152320	38825.152320	6.11	0.0213
Error	23	146181.807680	6355.730769		
Corrected Total	24	185006.960000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.209858	34.22168	79.722837	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WETIN	1	38825.152320	38825.152320	6.11	0.0213

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WETIN	1	38825.152320	38825.152320	6.11	0.0213

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate

INTERCEPT	100.0222261	1.78	0.0878	56.10021263
WETIN	0.2535432	2.47	0.0213	0.10258365

General Linear Models Procedure

Number of observations in data set = 25

Dependent Variable: NITEXC

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	176039.65105	176039.65105	451.52	0.0001
Error	23	8967.30895	389.88300		
Corrected Total	24	185006.96000			

R-Square	C.V.	Root MSE	NITEXC Mean
0.951530	8.475899	19.745455	232.96000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
NITIN	1	176039.65105	176039.65105	451.52	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
NITIN	1	176039.65105	176039.65105	451.52	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	101.0865832	13.74	0.0001	7.35602243
NITIN	0.6469457	21.25	0.0001	0.03044597

General Linear Models Procedure

Number of observations in data set = 24

Dependent Variable: NITEXC

		Sum of	Mean

Source	DF	Squares	Square	F Value	Pr > F
Model	4	149312.07023	37328.01756	171.19	0.0001
Error	19	4142.88811	218.04674		
Corrected Total	23	153454.95833			

R-Square	C.V.	Root MSE	NITEXC Mean
0.973003	6.542251	14.766406	225.70833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WEIGHT	1	87.463799	87.463799	0.40	0.5341
DRYIN	1	90700.146946	90700.146946	415.97	0.0001
WETIN	1	23776.165059	23776.165059	109.04	0.0001
NITIN	1	34748.294422	34748.294422	159.36	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WEIGHT	1	60.793717	60.793717	0.28	0.6036
DRYIN	1	6.738208	6.738208	0.03	0.8623
WETIN	1	160.526891	160.526891	0.74	0.4016
NITIN	1	34748.294422	34748.294422	159.36	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	120.9427459	1.83	0.0833	66.15307630
WEIGHT	-0.0106577	-0.53	0.6036	0.02018413
DRYIN	-0.0303766	-0.18	0.8623	0.17279917
WETIN	0.0559731	0.86	0.4016	0.06523492
NITIN	0.6013292	12.62	0.0001	0.04763436

General Linear Models Procedure

Number of observations in data set = 24

Dependent Variable: NITEXC

	Sum of	Mean

Source	DF	Squares	Square	F Value	Pr > F
Model	2	149207.36221	74603.68110	368.84	0.0001
Error	21	4247.59613	202.26648		
Corrected Total	23	153454.95833			

R-Square	C.V.	Root MSE	NITEXC Mean
0.972320	6.301071	14.222042	225.70833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WETIN	1	43049.04121	43049.04121	212.83	0.0001
NITIN	1	106158.32099	106158.32099	524.84	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WETIN	1	1136.06481	1136.06481	5.62	0.0274
NITIN	1	106158.32099	106158.32099	524.84	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	83.94089243	8.33	0.0001	10.07143175
WETIN	0.04896725	2.37	0.0274	0.02066170
NITIN	0.59110598	22.91	0.0001	0.02580182