Self-Assessment
Weeks 11: ANOVA and Regression

1. Linked below are the blood pressure data files that were presented in previous self-assessments.

SPSS
http://www.bwgriffin.com/gsu/courses/edur8132/selfassessments/Week09/BloodPressureDrugs.sav

Excel
http://www.bwgriffin.com/gsu/courses/edur8132/selfassessments/Week09/BloodPressureDrugs.xlsx

Perform the following analysis using ANOVA and regression comparing diastolic blood pressure among the four drug treatments (Ziac, Losartan, Lisinopril 40mg, Lisinopril 12.5mg), i.e.,

Systolic Blood Pressure = b0 + Drug Treatment

(a) Compare the ANOVA summary table between regression and ANOVA. What similarities do you notice?

Both ANOVA and Regression produce the same model summary statistics in their corresponding ANOVA tables:

Component	ANOVA Results	Regression Results
Model F	**2.26**	**2.26**
Model SS	**235.69**	**235.69**
Error SS	**2501.93**	**2501.93**
Model DF	**3**	**3**
Error DF	**72**	**72**

(b) Compare model fit between ANOVA and regression. What similarities do you notice?

Both ANOVA and Regression produce the same model fit indices.

Component	ANOVA Results	Regression Results
R^2	**.086**	**.086**
Adjusted R^2	**.048**	**.048**
SSE	$\sqrt{34.749}$ **= 5.89**	**5.89**
MSE	**34.74**	**34.74**

Note: If ANOVA results do not present an R^2 value, it can be calculated by taking the ratio of the model sums of squares (SS) divided by the total SS. For example, of the model SS is 25 and the total SS is 100, the R^2 = 25/100 = .25. IF using SPSS Unianova (General Linear Model) command, use the ratio of the corrected model SS to the corrected total SS to find the model R^2.

(c) Compare both Bonferroni and Scheffé CIs for the pairwise comparisons. What similarities do you notice?

Both produce the same values (only the first three comparisons are presented below as examples):

Comparison	ANOVA Results			Regression Results		
	Mean Diff	Lower Limit	Upper Limit	Mean Diff	Lower Limit	Upper Limit
Bonferroni						
Lisin 40 vs. Lisin 12.5	-1.56	-6.77	3.65	-1.56	-6.77	3.65
Losart vs. Lisin 12.5	3.23	-1.69	8.17	3.23	-1.69	8.17
Ziac vs. Lisin 12.5	0.20	-5.01	5.42	0.20	-5.01	5.42
Scheffé						
Lisin 40 vs. Lisin 12.5	-1.56	-7.06	3.94	-1.56	-7.06	3.94
Losart vs. Lisin 12.5	3.23	-1.96	8.44	3.23	-1.96	8.44
Ziac vs. Lisin 12.5	0.20	-5.30	5.71	0.20	-5.30	5.71

(d) After studying the above results, what conclusions do you draw about ANOVA and regression?

Mathematically if appears both ANOVA and Regression produce the same results but in different forms.

Note: See end of document for software output for Questions 1, 2, and 3.

2. Below is a data file containing the following variables for cars taken between 1970 and 1982:

mpg: miles per gallon
engine: engine displacement in cubic inches
horse: horsepower
weight: vehicle weight in pounds
accel: time to accelerate from 0 to 60 mph in seconds
year: model year (70 = 1970, to 82 = 1982)
origin: country of origin (1=American, 2=Europe, 3=Japan)
cylinder: number of cylinders

SPSS Data: http://www.bwgriffin.com/gsu/courses/edur8132/selfassessments/Week04/cars_missing_deleted.sav
(Note: There are underscore marks between words in the SPSS data file name.)
Other Data Format: If you prefer a data file format other than SPSS, let me know.

For this problem we wish to know whether MPG differs among car origins and number of cylinders. The regression model for this study follows:

Predicted MPG = b0 + origin of car + number of cylinders

Origin of car is categorical. Number of cylinders may appear to be ratio, but since observed categories of this variable are limited, it is best to treat this variable as categorical. Note the following number of cylinders reported:

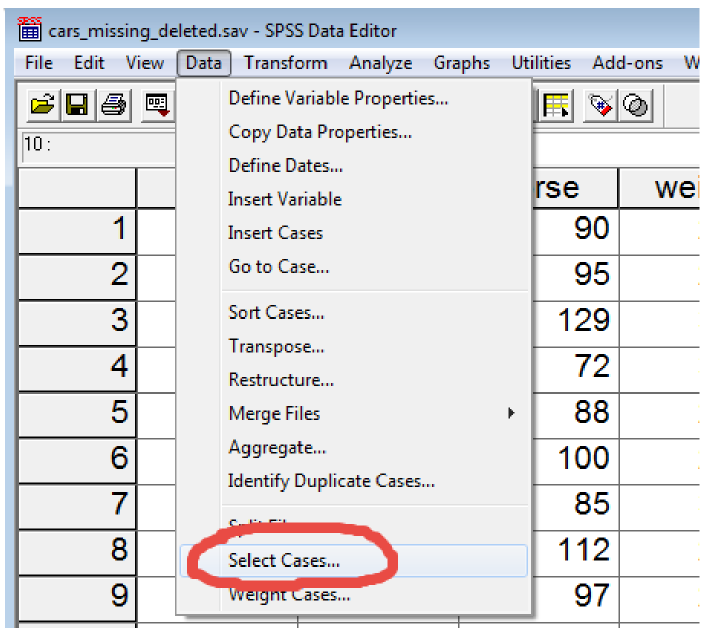
Number of Cylinders

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 Cylinders	4	1.0	1.0	1.0
	4 Cylinders	199	50.9	50.9	51.9
	5 Cylinders	3	.8	.8	52.7
	6 Cylinders	83	21.2	21.2	73.9
	8 Cylinders	102	26.1	26.1	100.0
	Total	391	100.0	100.0	

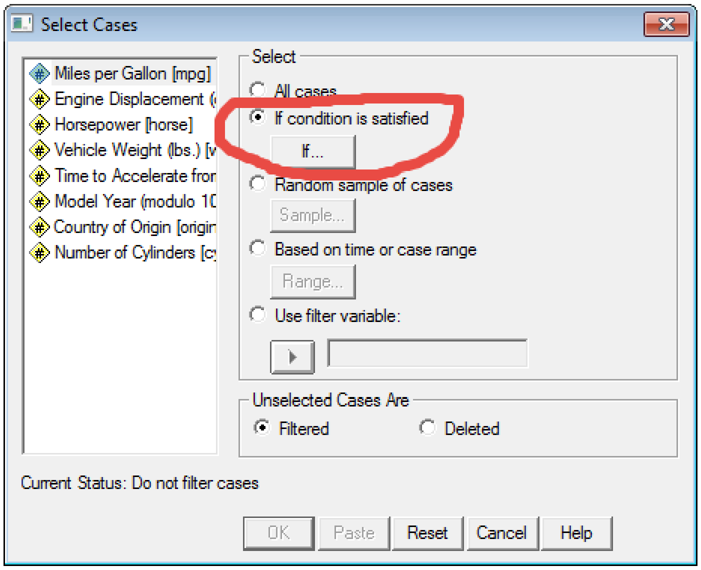
As the frequency display above shows, the number of cylinders include 3, 4, 5, 6, and 8. However, only 4 cars had 3 cylinders and only 3 cars had 5 cylinders. Given the small sample sizes for these categories, it is best to remove these cases from the regression analysis. There are several ways to accomplish this. Four approaches are (a) manually delete these cases after sorting all cases on number of cylinders, (b) telling SPSS to treat these 7 cases as missing values so they will not be included in any analysis (use Recode into Same Variable and set 3 Cylinders and 5 Cylinders as system missing), (c) defining 3 and 5 Cylinders as missing values in the variable missing values, or (d) using the Select Cases command to filter these cases from all analyses. Other possibilities also exist.

Of these four, option (d) works well and does not require deletion of any cases. This option is explained below.

Step 1: Open the Select Case window



Step 2: Choose the select If option



Step 3: Define the filter so SPSS can determine which cases NOT to select.

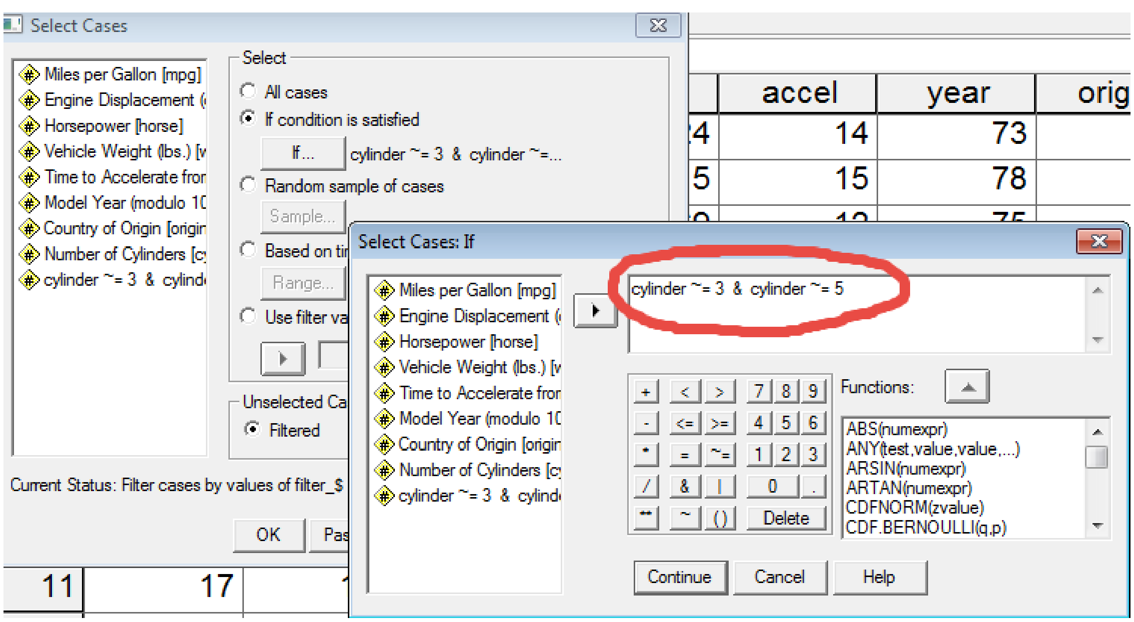
We do not want cylinders of 3 or 5, so in the Select Cases IF box, write

cylinders ~= 3

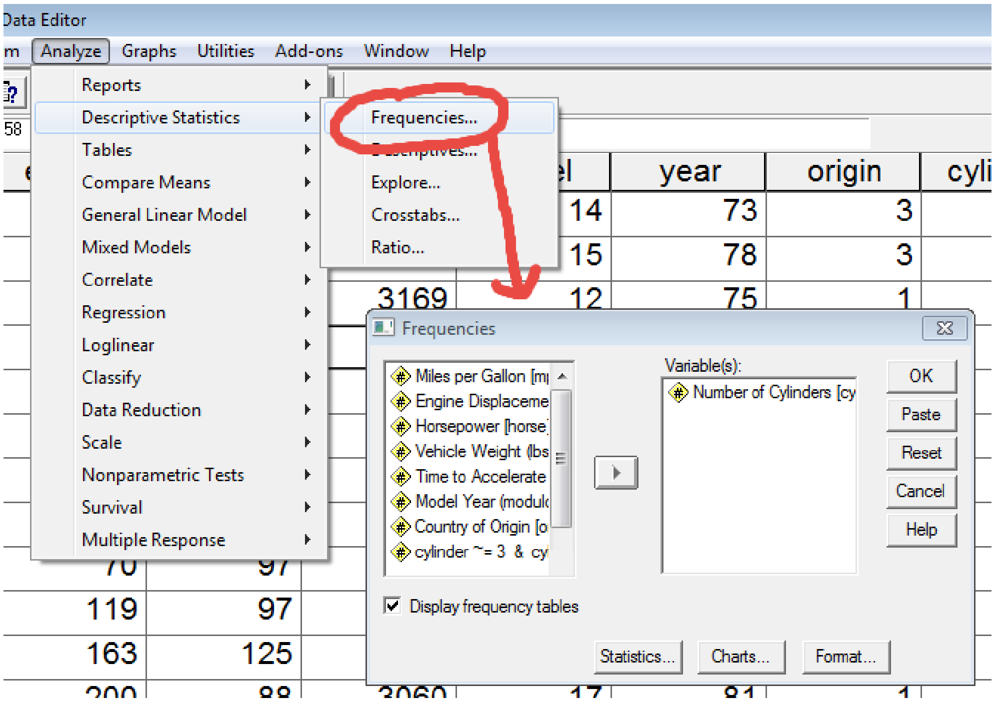
The symbol ~= means "not equal"; this tells SPSS not to select any cases in which cylinders are 3. Also, write

cylinders ~= 5

so SPSS knows not to select cases when cylinders are 5. To combine these two, we use the ampersand symbol, &, which means select all cases which are not 3 and 5 cylinders. See image below.



Once these cases are defined, click Continue then OK to process this command. Next, check that the appropriate cases were selected by running the Frequency command for cylinders as shown below.



And the results should look like this:

Frequencies

Statistics

Number of Cylinders

N	Valid	384
	Missing	0

Number of Cylinders

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4 Cylinders	199	51.8	51.8	51.8
	6 Cylinders	83	21.6	21.6	73.4
	8 Cylinders	102	26.6	26.6	100.0
	Total	384	100.0	100.0	

Note that no cases of cylinders equal to 3 or 5 were selected.

(a) Compare the ANOVA summary table between regression and ANOVA. What similarities do you notice for the overall model test? Note that when running General Linear Model in SPSS, you must specify a custom model that does NOT include the interaction between Origins and Cylinders. Also, when comparing overall models in the ANOVA summary table, use the Corrected Model line from the General Linear Model output since this line tests the complete model.

Both ANOVA and Regression produce the same model summary statistics in their corresponding ANOVA tables:

Component	ANOVA Results	Regression Results
Model F	**193.20**	**193.20**
Model SS	**15683.62**	**15683.62**
Error SS	**7691.35**	**7691.35**
Model DF	**4**	**4**
Error DF	**379**	**379**

(b) Compare model fit between ANOVA and regression. What similarities do you notice?

Both ANOVA and Regression produce the same model fit indices.

Component	ANOVA Results	Regression Results
R^2	**.671**	**.671**
Adjusted R^2	**.667**	**.667**
SSE	$\sqrt{20.294}$ **= 4.504**	**4.505**
MSE	**20.294**	**20.294**

Note: If ANOVA results do not present an R^2 value, it can be calculated by taking the ratio of the model sums of squares (SS) divided by the total SS. For example, of the model SS is 25 and the total SS is 100, the $R^2 = 25/100 = .25$. IF using SPSS Unianova (General Linear Model) command, use the ratio of the corrected model SS to the corrected total SS to find the model R^2.

(c) Compare partial F tests (i.e., F ratio, degrees of freedom) for Origins and Number of Cylinders between ANOVA and Regression. Recall that to obtain the partial F test in Regression, you must test the variable contribute by testing the ΔR^2 value.

Both ANOVA and Regression produce the same partial F test results.

Component	ANOVA Results	Regression Results
Origin		
F	**16.31**	**16.31**
df1	**2**	**2**
SS	**662.08**	**662.08**
Cylinders		
F	**185.59**	**185.59**
df1	**2**	**2**
SS	**7532.79**	**7532.79**

(d) After studying the above results, what conclusions do you draw about ANOVA and regression when used to analyze more than one predictor?

As with Question 1, both ANOVA and Regression produce the same results, so mathematically they appear to be the same.

3. Using the same cars data provided in Question 2, perform a two-way ANOVA on MPG with Origins and Number of Cylinders as the predictors, i.e.,

Predicted MPG = b0 + origin of car + number of cylinders

and ANOVA report results in APA style. Set alpha = .05 and use the Bonferroni adjustment for any multiple comparisons that are performed.

Table 1: Descriptive Statistics of MPG by Origins and Number of Cylinders

	MPG		
	M	**SD**	**n**
Origin			
American	**20.08**	**6.41**	**244**
European	**27.61**	**6.57**	**65**
Japanese	**30.98**	**5.77**	**75**
Number of Cylinders			
4	**29.28**	**5.67**	**199**
6	**19.97**	**3.83**	**83**
8	**15.02**	**2.79**	**102**

Table 2: ANOVA Summary for MPG by Orign and Number of Cylinders

Source	SS	df	MS	F
Origin	**662.09**	**2**	**331.04**	**16.31***
Cylinders	**7532.80**	**2**	**3766.40**	**185.59***
Error	**7691.36**	**379**	**20.29**	

Note: **R^2 = .67*, adj. R^2 = .66*.**
*** p < .05**

Table 3: Comparisons of Mean Differences in MPG by Origin

Origin of Vehicle	Estimated Mean Difference	Standard Error of Difference	Bonferroni Adjusted 95% CI
American vs. European	**-0.166**	**0.740**	**-1.95, 1.61**
American vs. Japanese	**-3.683***	**0.706**	**-5.38, -1.99**
European vs. Japanese	**-3.517***	**0.764**	**-5.35, -1.68**

*** p < .05, where p-values are adjusted using the Bonferroni method**

Table 4: Comparisons of Mean Differences in MPG by Number of Cylinders

Number of Cylinders	Estimated Mean Difference	Standard Error of Difference	Bonferroni Adjusted 95% CI
4 vs. 6	8.257*	0.673	6.64, 9.88
4 vs. 8	12.934*	0.680	11.30, 14.57
6 vs. 8	4.678*	0.670	3.07, 6.29

*** $p < .05$, where p-values are adjusted using the Bonferroni method**

Results of the two-way ANOVA show that mean MPG differ statistically by both vehicle origin and number of cylinders. Results show that Japanese vehicles tend to have statistically higher MPG than either European and American vehicles, and that European and American vehicles appear to have similar (i.e., not statistically significant) MPG performance. For number of cylinders, there is clear evidence that as the number of cylinders increases, MPG decrease. Vehicles with 4 cylinders obtained better MPG than vehicles with either 6 or 8 cylinders, and vehicles with 6 cylinders obtain better MPG than vehicles with 8 cylinders.

Question 1 Software Output

Regression Output

```
. regress meanlowdiastolic i.drug_num

      Source |       SS           df       MS      Number of obs   =        76
-------------+----------------------------------   F(3, 72)        =      2.26
       Model |  235.696005         3  78.5653349   Prob > F        =    0.0886
    Residual |  2501.93557        72  34.7491052   R-squared       =    0.0861
-------------+----------------------------------   Adj R-squared   =    0.0480
       Total |  2737.63158        75  36.5017544   Root MSE        =    5.8948

------------------------------------------------------------------------------
meanlowdia~c |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    drug_num |
          2  |  -1.560224   1.923222    -0.81   0.420    -5.394098     2.27365
          3  |   3.238095   1.819186     1.78   0.079    -.3883863    6.864577
          4  |   .2044818   1.923222     0.11   0.916    -3.629392    4.038356
             |
       _cons |    100.119   1.286359    77.83   0.000     97.55474    102.6834
------------------------------------------------------------------------------

. tabulate drug_num , gen( drug_num )

   drug_num |      Freq.     Percent        Cum.
------------+-----------------------------------
          1 |         21       27.63       27.63
          2 |         17       22.37       50.00
          3 |         21       27.63       77.63
          4 |         17       22.37      100.00
------------+-----------------------------------
      Total |         76      100.00

. tabulate drug

           drug |      Freq.     Percent        Cum.
----------------+-----------------------------------
lisinopril_12_5 |         21       27.63       27.63
  lisinopril_40 |         17       22.37       50.00
    losartan_50 |         21       27.63       77.63
        ziac_10 |         17       22.37      100.00
----------------+-----------------------------------
          Total |         76      100.00
```

```
.  margins drug_num, mcompare(bonferroni) pwcompare level(95)
Pairwise comparisons of adjusted predictions
Model VCE    : OLS
Expression   : Linear prediction, predict()

--------------------------------------------------------------
             |            Delta-method         Bonferroni
             |   Contrast   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
    drug_num |
     2 vs 1  |  -1.560224   1.923222     -6.778134    3.657686
     3 vs 1  |   3.238095   1.819186     -1.697553    8.173744
     4 vs 1  |   .2044818   1.923222     -5.013428    5.422392
     3 vs 2  |   4.798319   1.923222     -.4195905    10.01623
     4 vs 2  |   1.764706   2.021912     -3.720961    7.250373
     4 vs 3  |  -3.033613   1.923222     -8.251523    2.184296
--------------------------------------------------------------

.  margins drug_num, mcompare(scheffe) pwcompare level(95)
Pairwise comparisons of adjusted predictions
Model VCE    : OLS
Expression   : Linear prediction, predict()

--------------------------------------------------------------
             |            Delta-method          Scheffe
             |   Contrast   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
    drug_num |
     2 vs 1  |  -1.560224   1.923222     -7.065957    3.945509
     3 vs 1  |   3.238095   1.819186     -1.969807    8.445997
     4 vs 1  |   .2044818   1.923222     -5.301251    5.710215
     3 vs 2  |   4.798319   1.923222     -.7074136    10.30405
     4 vs 2  |   1.764706   2.021912     -4.023554    7.552965
     4 vs 3  |  -3.033613   1.923222     -8.539346    2.472119
--------------------------------------------------------------
```

Results of SPSS Oneway Command

Descriptives

diastolic_bp

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Lisinopril 12.5	21	100.1190	5.26997	1.15000	97.7202	102.5179	92.50	109.00
Lisinopril 40	17	98.5588	8.10263	1.96518	94.3928	102.7248	84.00	112.50
Losartan	21	103.3571	4.44450	.96987	101.3340	105.3803	90.00	110.00
Ziac	17	100.3235	5.59559	1.35713	97.4465	103.2005	87.50	108.00
Total	76	100.7105	6.04167	.69303	99.3299	102.0911	84.00	112.50

ANOVA

diastolic_bp

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	235.696	3	78.565	2.261	.089
Within Groups	2501.936	72	34.749		
Total	2737.632	75			

Multiple Comparisons

Dependent Variable: diastolic_bp

	(I) drug_num	(J) drug_num	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Scheffe	Lisinopril 12.5	Lisinopril 40	1.56022	1.92322	.883	-3.9455	7.0660
		Losartan	-3.23810	1.81919	.373	-8.4460	1.9698
		Ziac	-.20448	1.92322	1.000	-5.7102	5.3013
	Lisinopril 40	Lisinopril 12.5	-1.56022	1.92322	.883	-7.0660	3.9455
		Losartan	-4.79832	1.92322	.111	-10.3041	.7074
		Ziac	-1.76471	2.02191	.858	-7.5530	4.0236
	Losartan	Lisinopril 12.5	3.23810	1.81919	.373	-1.9698	8.4460
		Lisinopril 40	4.79832	1.92322	.111	-.7074	10.3041
		Ziac	3.03361	1.92322	.482	-2.4721	8.5393
	Ziac	Lisinopril 12.5	.20448	1.92322	1.000	-5.3013	5.7102
		Lisinopril 40	1.76471	2.02191	.858	-4.0236	7.5530
		Losartan	-3.03361	1.92322	.482	-8.5393	2.4721
Bonferroni	Lisinopril 12.5	Lisinopril 40	1.56022	1.92322	1.000	-3.6577	6.7781
		Losartan	-3.23810	1.81919	.476	-8.1737	1.6976
		Ziac	-.20448	1.92322	1.000	-5.4224	5.0134
	Lisinopril 40	Lisinopril 12.5	-1.56022	1.92322	1.000	-6.7781	3.6577
		Losartan	-4.79832	1.92322	.089	-10.0162	.4196
		Ziac	-1.76471	2.02191	1.000	-7.2504	3.7210
	Losartan	Lisinopril 12.5	3.23810	1.81919	.476	-1.6976	8.1737
		Lisinopril 40	4.79832	1.92322	.089	-.4196	10.0162
		Ziac	3.03361	1.92322	.715	-2.1843	8.2515
	Ziac	Lisinopril 12.5	.20448	1.92322	1.000	-5.0134	5.4224
		Lisinopril 40	1.76471	2.02191	1.000	-3.7210	7.2504
		Losartan	-3.03361	1.92322	.715	-8.2515	2.1843

Results of SPSS Unianova Command

Descriptive Statistics

Dependent Variable: diastolic_bp

drug	Mean	Std. Deviation	N
lisinopril_12_5	100.1190	5.26997	21
lisinopril_40	98.5588	8.10263	17
losartan_50	103.3571	4.44450	21
ziac_10	100.3235	5.59559	17
Total	100.7105	6.04167	76

Tests of Between-Subjects Effects

Dependent Variable: diastolic_bp

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	235.696(a)	3	78.565	2.261	.089
Intercept	760468.235	1	760468.235	21884.542	.000
drug	235.696	3	78.565	2.261	.089
Error	2501.936	72	34.749		
Total	773576.000	76			
Corrected Total	2737.632	75			

a R Squared = .086 (Adjusted R Squared = .048)

Estimates

Dependent Variable: diastolic_bp

drug	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
lisinopril_12_5	100.119	1.286	97.555	102.683
lisinopril_40	98.559	1.430	95.709	101.409
losartan_50	103.357	1.286	100.793	105.921
ziac_10	100.324	1.430	97.473	103.174

Multiple Comparisons

Dependent Variable: diastolic_bp

	(I) drug	(J) drug	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Scheffe	lisinopril_12_5	lisinopril_40	1.5602	1.92322	.883	-3.9455	7.0660
		losartan_50	-3.2381	1.81919	.373	-8.4460	1.9698
		ziac_10	-.2045	1.92322	1.000	-5.7102	5.3013
	lisinopril_40	lisinopril_12_5	-1.5602	1.92322	.883	-7.0660	3.9455
		losartan_50	-4.7983	1.92322	.111	-10.3041	.7074
		ziac_10	-1.7647	2.02191	.858	-7.5530	4.0236
	losartan_50	lisinopril_12_5	3.2381	1.81919	.373	-1.9698	8.4460
		lisinopril_40	4.7983	1.92322	.111	-.7074	10.3041
		ziac_10	3.0336	1.92322	.482	-2.4721	8.5393
	ziac_10	lisinopril_12_5	.2045	1.92322	1.000	-5.3013	5.7102
		lisinopril_40	1.7647	2.02191	.858	-4.0236	7.5530
		losartan_50	-3.0336	1.92322	.482	-8.5393	2.4721
Bonferroni	lisinopril_12_5	lisinopril_40	1.5602	1.92322	1.000	-3.6577	6.7781
		losartan_50	-3.2381	1.81919	.476	-8.1737	1.6976
		ziac_10	-.2045	1.92322	1.000	-5.4224	5.0134
	lisinopril_40	lisinopril_12_5	-1.5602	1.92322	1.000	-6.7781	3.6577
		losartan_50	-4.7983	1.92322	.089	-10.0162	.4196
		ziac_10	-1.7647	2.02191	1.000	-7.2504	3.7210
	losartan_50	lisinopril_12_5	3.2381	1.81919	.476	-1.6976	8.1737
		lisinopril_40	4.7983	1.92322	.089	-.4196	10.0162
		ziac_10	3.0336	1.92322	.715	-2.1843	8.2515
	ziac_10	lisinopril_12_5	.2045	1.92322	1.000	-5.0134	5.4224
		lisinopril_40	1.7647	2.02191	1.000	-3.7210	7.2504
		losartan_50	-3.0336	1.92322	.715	-8.2515	2.1843

Based on observed means.

Question 2 Software Output

General Linear Model ANOVA results

Tests of Between-Subjects Effects

Dependent Variable: Miles per Gallon

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15683.625(a)	4	3920.906	193.207	.000
Intercept	80479.626	1	80479.626	3965.722	.000
origin	662.088	2	331.044	16.313	.000
cylinder	7532.798	2	3766.399	185.593	.000
Error	7691.355	379	20.294		
Total	235133.590	384			
Corrected Total	23374.980	383			

a R Squared = .671 (Adjusted R Squared = .667)

Regression Results

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.819(a)	.671	.667	4.505

a Predictors: (Constant), Cylinder6, European, Cylinder4, American

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15683.625	4	3920.906	193.207	.000(a)
	Residual	7691.355	379	20.294		
	Total	23374.980	383			

a Predictors: (Constant), Cylinder6, European, Cylinder4, American

b Dependent Variable: Miles per Gallon

ANOVA(c)

Model			Sum of Squares	df	Mean Square	F	Sig.	R Square Change
1	Subset Tests	American, European	662.088	2	331.044	16.313	.000(a)	.028
		Cylinder4, Cylinder6	7532.798	2	3766.399	185.593	.000(a)	.322
	Regression		15683.625	4	3920.906	193.207	.000(b)	
	Residual		7691.355	379	20.294			
	Total		23374.980	383				

a Tested against the full model.

b Predictors in the Full Model: (Constant), Cylinder6, European, Cylinder4, American.

c Dependent Variable: Miles per Gallon

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	18.705	.835		22.390	.000
	American	-3.683	.706	-.227	-5.214	.000
	European	-3.517	.764	-.169	-4.607	.000
	Cylinder4	12.934	.680	.828	19.035	.000
	Cylinder6	4.678	.670	.247	6.981	.000

a Dependent Variable: Miles per Gallon

Question 3 Software Output

Descriptive Statistics

Dependent Variable: Miles per Gallon

Country of Origin	Number of Cylinders	Mean	Std. Deviation	N
American	4 Cylinders	28.01	4.567	69
	6 Cylinders	19.65	3.395	73
	8 Cylinders	15.02	2.787	102
	Total	20.08	6.415	244
European	4 Cylinders	28.11	6.291	61
	6 Cylinders	20.10	7.074	4
	Total	27.61	6.573	65
Japanese	4 Cylinders	31.60	5.436	69
	6 Cylinders	23.88	4.952	6
	Total	30.98	5.766	75
Total	4 Cylinders	29.28	5.671	199
	6 Cylinders	19.97	3.829	83
	8 Cylinders	15.02	2.787	102
	Total	23.48	7.812	384

Tests of Between-Subjects Effects

Dependent Variable: Miles per Gallon

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15683.625(a)	4	3920.906	193.207	.000
Intercept	80479.626	1	80479.626	3965.722	.000
origin	662.088	2	331.044	16.313	.000
cylinder	7532.798	2	3766.399	185.593	.000
Error	7691.355	379	20.294		
Total	235133.590	384			
Corrected Total	23374.980	383			

a R Squared = .671 (Adjusted R Squared = .667)

Estimated Marginal Means

Estimates

Dependent Variable: Miles per Gallon

Country of Origin	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
American	20.892	.293	20.317	21.468
European	21.058	.663	19.755	22.361
Japanese	24.576	.625	23.347	25.804

Pairwise Comparisons

Dependent Variable: Miles per Gallon

(I) Country of Origin	(J) Country of Origin	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
American	European	-.166	.740	1.000	-1.946	1.614
	Japanese	-3.683(*)	.706	.000	-5.382	-1.985
European	American	.166	.740	1.000	-1.614	1.946
	Japanese	-3.517(*)	.764	.000	-5.353	-1.681
Japanese	American	3.683(*)	.706	.000	1.985	5.382
	European	3.517(*)	.764	.000	1.681	5.353

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Estimates

Dependent Variable: Miles per Gallon

Number of Cylinders	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
4 Cylinders	29.239	.320	28.610	29.868
6 Cylinders	20.982	.598	19.807	22.158
8 Cylinders	16.305	.606	15.114	17.496

Pairwise Comparisons

Dependent Variable: Miles per Gallon

(I) Number of Cylinders	(J) Number of Cylinders	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
4 Cylinders	6 Cylinders	8.257(*)	.673	.000	6.637	9.876
	8 Cylinders	12.934(*)	.680	.000	11.300	14.568
6 Cylinders	4 Cylinders	-8.257(*)	.673	.000	-9.876	-6.637
	8 Cylinders	4.678(*)	.670	.000	3.066	6.289
8 Cylinders	4 Cylinders	-12.934(*)	.680	.000	-14.568	-11.300
	6 Cylinders	-4.678(*)	.670	.000	-6.289	-3.066

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.